

# THE MODEL ENGINEER

Vol. 94 No. 2347 THURSDAY MAY 2 1946 6d



*Mr. G. V. Purves, of Toronto, Canada, driving his 7½-in. gauge 4-4-2 type locomotive, taking a bend at speed*

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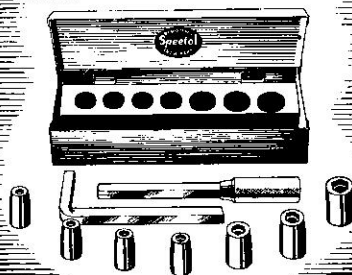
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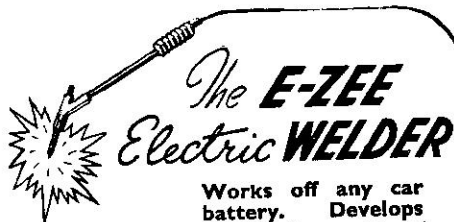


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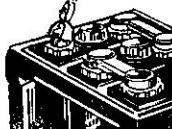
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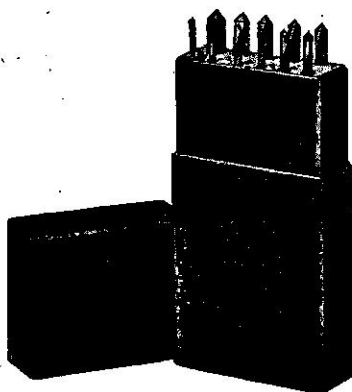
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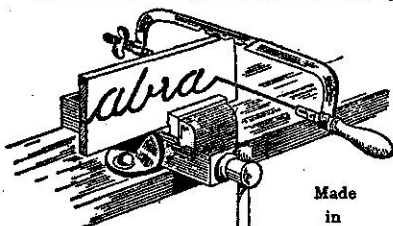
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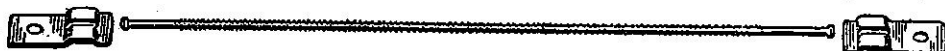
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# THE MODEL ENGINEER

MAY 2nd, 1946  
VOL. 94. No. 2347

## Smoke Rings

### Our Exhibition Competitions

ENTRY forms and full particulars of the competition section of the forthcoming MODEL ENGINEER Exhibition are now ready, and may be obtained post free on application to the Exhibition Manager, 23, Great Queen Street, London, W.C.2. The organising joint committee have this year planned the competitions on rather more elaborate lines than in previous years. A classification scheme has been adopted dividing the entries into well-defined separate classes in each of which medals, prizes and diplomas will be awarded. Championship trophies, not necessarily cups, will be offered in the engineering, marine, and aeronautical sections, and there will in addition be a number of special prizes kindly offered by friends of the Exhibition. The "Admiral's" Cup for the best model made by a lady competitor, and the "Stevens" Cup for the best model following real engineering practice will again be available. A liberal share of the prizes will be devoted to the recognition of meritorious work by juniors under the age of 17. The last day for returning entry forms will be July 13th, and as a heavy entry is expected on this occasion, early application for forms should be made. A considerable portion of the space available for trade stands has already been taken up, and firms desirous of being represented should not delay in making their decision if they wish to secure a good position. There will be many meetings of old friends and new friends, and there is no doubt that the 1946 Exhibition, the 21st birthday show, will be a memorable occasion in the annals of model engineering in all its aspects. Note the date—opening Thursday, August 22nd, closing Saturday, the 31st. No one, whether trade or private, should miss it.

### Power Boat Prototypes

MODEL power boat builders who are looking for attractive prototypes for their skill may find much inspiration in the lines of some of the newer cargo boats and tankers which are leaving or have left the shipbuilders' yards. Some of these new ships are very graceful in design, and the absence of elaborate deck fittings in both cargo boats and tankers make these types particularly suitable

for working models which require careful transport and much handling at the pond side. A good example of the modern cargo motorship is the *Riebeeck Castle*, built by Harland and Wolff Ltd., of Belfast, which has lately completed her trials. She will be put into service on the run between Southampton and South African ports.

### A Model Engineer at Home

AT Rocky River, Ohio, lives Mr. Percival Ward Wilson, whose name has for many years been familiar to THE MODEL ENGINEER readers as a frequent correspondent. In a recent package of editorial material, Mr. Wilson enclosed for my interest an admirable interior photograph of his sitting room, in which he is shown seated in a comfortable arm-chair with his favourite dog "Biddy," his constant workshop companion, at his feet; also in the room are Mrs. Wilson and a friend, Mr. Steinman, the General Superintendent of the American Shipbuilding Company's five shipyards. But that does not complete my interest in the picture, for I observe a fine model of a compound marine engine and a picture of a famous sailing ship, the original *Challenger*, afterwards re-named *Golden City*. She belonged to Mr. Wilson's father, and in her day was noteworthy for her fine passages in the China clipper days. I am grateful to Mr. Wilson for sending me this charming domestic picture, for it strengthens the ties of friendship which have always existed between us, even when so far apart. It is many years since Mr. Wilson first walked into THE MODEL ENGINEER office to talk marine engines with the Editor. He was then sailing as chief engineer between this country and India, and was as enthusiastic about models as he was about the engines of his ship. Shortly after that visit he took up an important appointment in the United States in connection with marine salvage, and can tell many enthralling yarns about shipwrecks on the Great Lakes and other American waters. The photograph he now sends me shows that he has lived well in spite of these adventures, and I am sure that his model workshop plays no small part in keeping careworn wrinkles away. I value these domestic notes from my reader friends very much, for they emphasise the family regard which is so strong between all who share in the fortunes and interests of THE MODEL ENGINEER and of "Smoke Rings" in particular.

*Percival Ward Wilson*

# A Four - Cylinder Radial-Type Steam Engine

By H. HOWELL

THE four-cylinder radial-type steam engine which I have recently completed, is very unusual in design, and has created much interest with model engineer friends. Others may find it interesting also, so I will endeavour to pass on the information in the form of an article, giving full details of the construction suitable for others to have a shot at making.

The design was based on a similar engine that appeared in *THE MODEL ENGINEER* some years ago, which I redesigned to suit my own requirements.

## A General Survey

There are four cylinders,  $\frac{3}{8}$ -in. bore  $\times$   $\frac{3}{4}$ -in. stroke, single-acting with piston type valves of  $\frac{1}{4}$ -in. diameter  $\times$   $\frac{1}{4}$ -in. stroke. The pistons are attached to the crankshaft with four connecting-rods on to a common centre, namely, con-rod centre, which is free on the crankpin. One con-rod is used as a master, fixed by two screws to the con-rod centre, the object being to control the position of the other three con-rods and pistons *via* the centre. To some this may become a little puzzling, but without the master the con-rods would tend to become entangled, some pushing, some pulling, and, of course, the valve-gear would be out of step, hence the master con-rod.

The four valves are operated from one eccen-

tric; secured to the crankshaft by means of a grub-screw. Adjustable valve-links are connected to a spider which is free on the eccentric and, here again, there is a master-valve link to control the position of the other valve-links, similar in principal to the pistons and con-rods as outlined above. This was an experiment and proved quite sound.

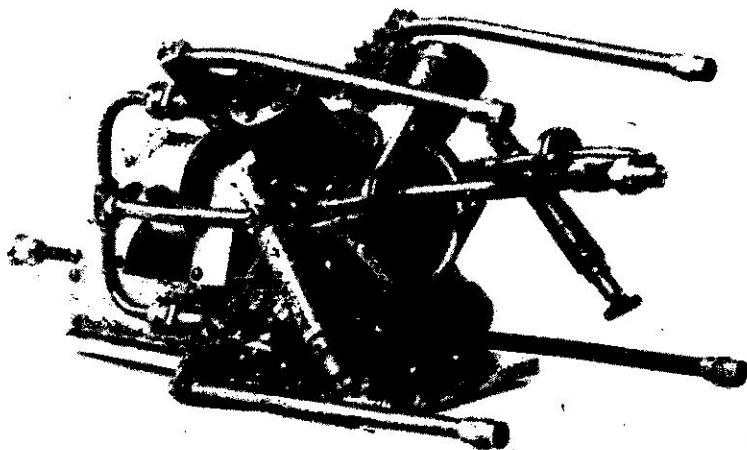
The crank system is enclosed in a crankcase equipped with an inspection cover. The con-rod ends, crankpin and centre are lubricated from an oil-container, situated on top of the crankcase, drip feed. Lubrication for the valves and cylinders is provided for by means of two displacement type lubricators, each feeding two cylinders through the steam inlet pipes. Perhaps a force-feed pump, driven from the engine, would be more suitable.

A gear drive from the crankshaft to a propeller shaft is shown on the general arrangement drawing, Fig. 1, to suit my own requirements, obviously for a boat. The installation and use of the engine governs the type of drive required and may be a direct drive needed, so I will deal with the engine as a complete unit without the drive.

## Details of Parts

A reasonable amount of accuracy will be required in the making of the various parts,

*Four-cylinder radial-type steam engine. General view, showing gearboxes*



owing to the fine clearances on assembly. All can be made with the aid of a small lathe, a driller, and the usual hand tools, no elaborate machinery being necessary, and as regards materials, most can be found in the scrap-box, as only very small amounts will be required. It will be noticed that the decimal system, except for standard diameters, is used throughout the drawings, I find this a better method on small details and obviates quoting bare and full on dimensions, but anyone who prefers the fraction

similar as regards drilling, and, therefore, interchangeable. When using the jigs take note of the markings to ensure correct matching.

The first job is to make two patterns, one for the cylinder and one for the valve-box. Make an allowance on the patterns for machining where marked *f* on the detail drawing, Fig. 2. Allow an extra on the length of the  $\frac{3}{4}$  in. diameter spigot (cylinder) for use when chucking the castings in the lathe. Taper will be required, of course, for withdrawing patterns from the

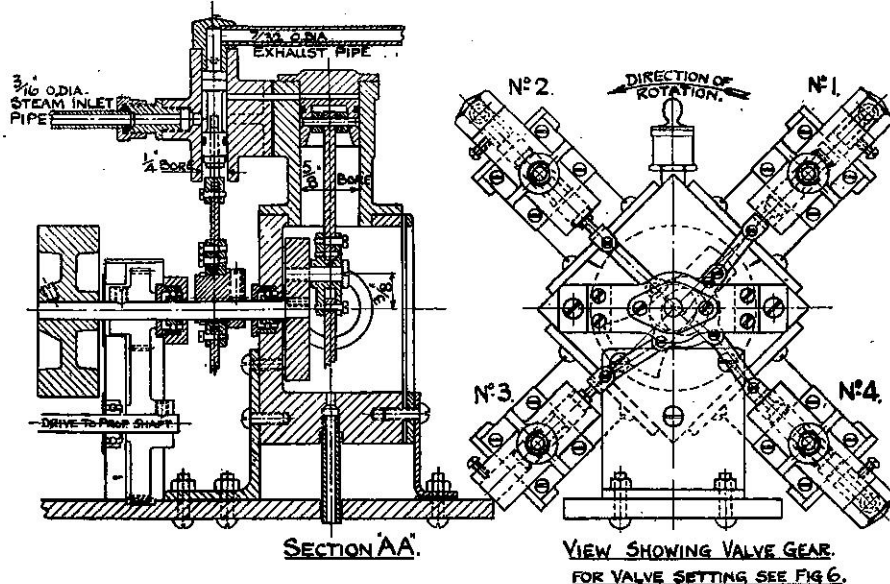


Fig. 1. General arrangement 4-cylinder radial-type steam engine

mould. The cylinders can have cored holes through the centre if prints of, say,  $\frac{1}{4}$  in. diameter are added, this will give a flying start for boring. The material, gunmetal or similar, and four required off each.

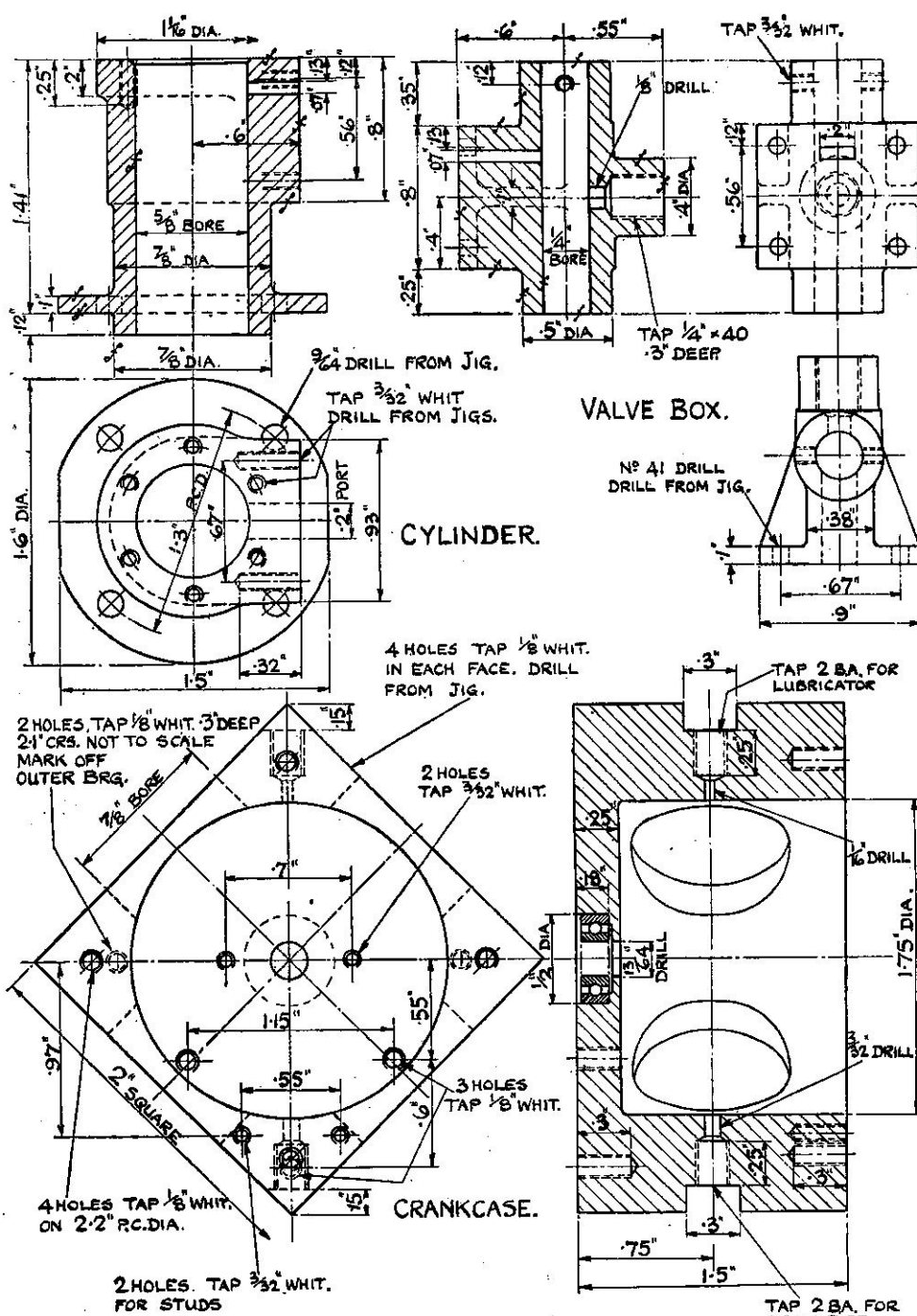
#### Crankcase

This can be commenced while the patterns are away at the foundry. A 2-in. square  $\times$   $1\frac{1}{2}$ -in. block of material will be required, either milled or faced up in the lathe. In my case round bar was used, the minimum size,  $2\frac{1}{4}$  in. diameter  $\times$   $2\frac{1}{16}$  in. long, both ends faced to a length of 2 in. in the lathe, then mounted on an angle-plate to produce the other four sides 2 in.  $\times$   $1\frac{1}{2}$  in. See that all sides are square if this method is adopted. The type of material is not important, except from a weight point of view. Having prepared the block, already scribed with centre-lines, proceed with the boring of the holes to drawing, Fig. 2. The  $\frac{1}{4}$  in. diameter bore for the ball races to be a push fit. Incidentally, if the ball races are not available these can be replaced with phosphor bronze or gunmetal bushes of the flanged type, but adequate lubrication must be provided.

The four holes tapped  $\frac{1}{8}$ -in. Whit. for attaching the cylinders to be drilled with the aid of jig

system can quite easily convert mentally to the nearest  $1/64$  in.

Since there are several groups of holes similar throughout the job, I found it a good plan to use drilling jigs made from odd bits of steel-plate, as shown in Fig. 5. These save quite a lot of time in marking out, particularly as there are several items of four off each, also all parts become



4 CYL. RADIAL TYPE STEAM ENGINE.  
FIG 2. DETAILS OF CYLINDERS, VALVE BOXES & CRANKCASE.



No. 2, made from  $\frac{1}{4}$ -in. plate. Locate jig with a piece of  $\frac{1}{8}$ -in. diameter bar, line up squarely to scribed centre-lines, clamp and drill through with a No. 40 drill, tapping size.

The two holes tapped  $\frac{1}{8}$ -in. Whit. 0.3 in. deep, are important, and must be drilled from the outer bearing bracket to maintain correct alignment of bearings for the crankshaft.

Turn up a clamp-bolt for the purpose, with a specially large head, this being inside the crankcase and a nut on the other end securing the outer bracket. The shank diameter to suit bearings.

### Cylinders and Valve Boxes

Turn up the castings in the lathe and bore a few thou. under size, ready for reaming "after" drilling the ports. I emphasise "after" because fray will appear during the operation of cutting the ports and all will be cleared on reaming.

The four holes and ports in both cylinders and valve-boxes to be drilled from jig No. 1, made from  $\frac{1}{4}$ -in. to  $\frac{3}{8}$ -in. thick plate. First, drill the four holes in the cylinders with the jig clamped squarely to scribed centre-lines, then screw on jig to port face and drill for ports. Try to squeeze another drilled hole between the two and clear with a drift. Repeat for valve-boxes.

Drill the four  $9/64$  in. holes in the cylinders from jig No. 2, again mounted squarely because the centre-lines of valves should pass through the centre of the crankshaft and all depends on this drilling operation.

The six  $3/32$ -in. Whit. tapped holes to be drilled from No. 3 jig, made from  $\frac{1}{4}$ -in. plate, which can be located with a short length of bar passed through cylinder bore and jig.

### Cylinder End Covers

Turn up from brass-bar and drill the six holes from jig No. 3. Actually, the 0.03 in. thickness shown on the top is not necessary, but improves the appearance. Four will be required.

### Outer Bearing

This bracket is made up in three parts with the centre portion bored in the lathe to  $\frac{1}{4}$ -in. diameter push fit, for the ball race. See crankcase notes regarding alternative to ball races.

### Bearing Retainers

As the name implies, fixes the outer races of the bearings to the outer bearing bracket, and the crankcase. Two will be required, made from  $\frac{1}{4}$ -in. thick brass-plate, filed to profile and skimmed up in the lathe to produce the 0.5 in. diameter.

### Pistons

Four required, and can be made quickly as follows. Take a short length of  $\frac{1}{8}$ -in. diameter silver-steel and drill squarely, four  $3/32$ -in. diameter holes for the gudgeon pins at 0.6-in. centres, with the first hole at about 0.3 in. from one end. Chuck in the lathe, face, drill, bore, groove and part each one off. Remove burrs and sharp corners with an oil stone while pistons are in the lathe.

### Gudgeon Pins

Four required,  $3/32$  in. diameter silver-steel.

### Connecting-Rods

Three plain and one master will be required made from  $\frac{1}{4}$ -in. steel-plate, and can be drilled from a jig made from steel-plate with two holes 1.25 in. centres.

### Con-Rod Centre

One required made from phosphor-bronze or brass. Phosphor bronze being the best material to resist wear. Provide one or two  $\frac{1}{16}$ -in. diameter oil-holes.

### Crankpin and Con-Rod Pins

Make from good quality steel bar, preferably high tensile for con-rod pins. It is important to turn the shanks a nice running fit without play also provide screw-driver slots in the heads. One crankpin and five con-rod pins will be required.

### Crankshaft

The balanced-type, built up with a web made from  $\frac{1}{4}$ -in. thick steel-plate and a shaft of  $\frac{3}{8}$ -in. diameter silver-steel turned down at one end to a press fit in the web and keyed with a  $3/32$ -in. grub-screw. One required complete. A washer will be required on assembly between the web and crankcase.

### Flywheel

Turned from steel-bar or cast-iron. The size is not important. Rough out and bore then mount on a mandrel and finally skim up in the lathe to ensure true running, as nothing looks worse than a wobbly flywheel.

The lubricator is made in two parts from brass hexagon, as shown, or brass-bar. To avoid the cap from falling off just centre-pop in two places around the spigot, which should be turned an easy push fit. You will find that it will click on and off.

The drain pipe is fitted to the underside of the crankcase, can be made from small bore tube or round bar.

All the engine parts already described are detailed on drawings, Fig. 2 and Fig. 3, and now we come to the valve-gear parts shown in Fig. 4.

### Piston Valves

Four required, make from silver-steel, or rustless, although difficulty may be experienced in tapping with the latter material. It will be noticed that there is no packing on the actual working portion of the valve, so this must be a very good sliding fit in the valve-box to avoid steam wastage and loss of power. Remove all burrs with an oil-stone so that the valve-box cover will not be scored.

### Eccentric Spider

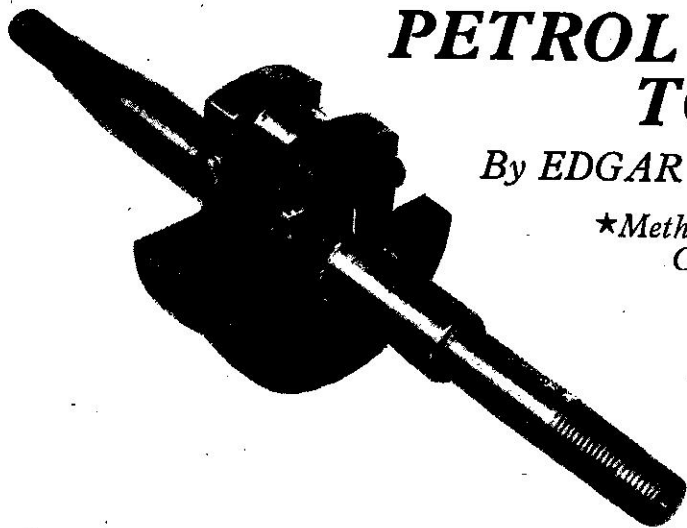
Machine from phosphor-bronze, minimum diameter  $1\frac{1}{8}$  in., and file profile. To produce a good bore use a  $\frac{1}{4}$ -in. reamer. Lubrication by means of the oil-can through the oil-hole, but if desired, a drip feed lubricator could be fitted.

(To be continued)

# PETROL ENGINE TOPICS

By EDGAR T. WESTBURY

## ★Methods of Making Crankshafts



alternative method of dividing the crankshaft is very often preferred, and may not only be simpler and less expensive, but also more satisfactory mechanically, given sound design and construction. This method imposes much less limitation on the type of bearing employed, as either the conventional forms of ball- or roller-bearings, or a plain bush bearing, may be fitted, and the connecting-rod may be made of any material which is mechanically suitable, without the need for hardening or special treatment in machining.

THE crankshafts so far dealt with have all been similar, in essential features of design and structure, when once their construction and machining are completed. In any engine design in which one of these crankshafts is specified, it would be practicable to use one of the others, with little or no modification of either design or dimensions. They are all, in their ultimate form, one-piece structures, and in the case of the "full" or double-bearing form of crankshaft, necessitate the use of a connecting-rod having the "big end" or crankpin bearing capable of being divided, or "split," for purposes of assembly.

While this form of construction is satisfactory for most general purposes, the "split big end" imposes certain limitations in design, and also in mechanical strength, which may be undesirable in high-speed or high-performance engines. In the first place, it is impossible to use ball or roller bearings on the crankpin of the conventional form of solid crankshaft. Certain types of crankshafts have been devised in which this limitation has been at least partially overcome, by arranging matters so that the eye of the connecting-rod can be threaded over the webs of the crankshaft, and the rollers afterwards assembled, being retained in place by split side cheeks, bolted on one or both sides of the bearing. The crankpin and the eye of the rod are both hardened, and form the inner and outer races of the bearing respectively.

This form of bearing, however, has never been highly popular in full-sized practice, and I have not seen it applied to a model. It results in a rather cumbersome assembly, the eye of the connecting-rod being necessarily very large in diameter, and the crank web, on the other hand, limited in shape and size; balance weights, when employed, must be bolted on after the connecting-rod bearing is assembled.

It will, therefore, be understood that the

### Building up from Detachable Components

The most common example of a "detachable" crankshaft used in full-size practice is that employed almost universally in motor-cycles. This has survived since the earliest days of their development, having been used in the first engines made by De Dion-Bouton, and while it has often been criticised by students of design, it is quite certain that no crankshaft more suitable for this specific purpose has ever been designed. Attempts to use one-piece crankshafts in motor-cycles have been fairly numerous in the history of their development, but apart from one or two notable examples, have generally proved abortive.

A characteristic feature of the motor-cycle

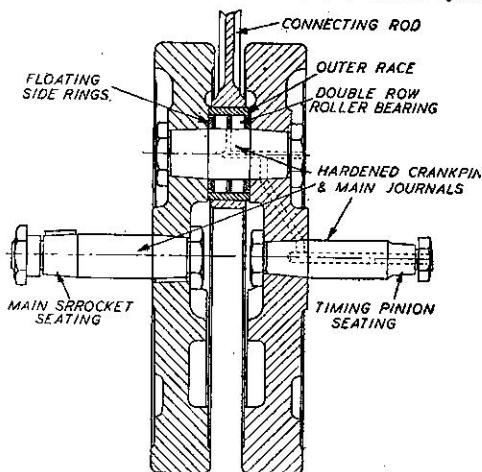


Fig. 13. Built-up crankshaft with internal flywheels, as employed in motor-cycle engines (drawn from actual example, one-fourth full size)

\* Continued from page 386, "M.E.," April 18, 1946.

crankshaft is the employment of large diameter internal flywheels, which not only form the crank discs or webs, but also contain the balance weights, and have rims sufficiently heavy to provide the necessary momentum for smooth running (Fig. 13). While the internal flywheels are not an inevitable or inseparable feature in this particular form of crankshaft structure, it may be in order to discuss their merits and limitations, for the benefit of any constructors who may contemplate using them.

In a motor-cycle engine, it is almost certain that the effect of the internal flywheels is entirely beneficial, since they take the shock of the power impulse on a massive "anvil" as near as possible to the crankpin, and thereby cushion the main shaft and bearings very considerably, so that both the wear and risk of breakdown are much reduced. This is a most important factor in the design of a powerful engine having only one, or at most, two cylinders, the individual "punch" of which, for a given power, must obviously be much heavier than that of a multi-cylinder engine.

When referring to the merits of the internal flywheel in the past, I have made use of an analogy which illustrates its effect fairly clearly. Many of us have encountered, in a fair or circus, the professional strong man who invites the "lads of the village" to crack heavy stones with a sledge-hammer on his chest. While agreeing that he is certainly a stout fellow, it is quite certain that the mass and inertia of the heavy stone prevents much of the actual impact force from reaching him at all; if a thin flat stone were placed on his chest and struck with equal force, the result would be very different.

It is sometimes objected that the heavy internal flywheels retard changes of speed, and thus hinder rapid acceleration; but this objection would apply equally to an external flywheel having an equivalent moment of inertia. A somewhat more serious objection, in modern engines of high r.p.m., is the "oil drag," or friction imposed by the clinging of viscous oil to the flywheel rims; but this is largely avoided by keeping the actual crankcase drained of oil, by means of a "dry sump" lubricating system.

In model petrol engines, the advantages of internal flywheels still apply, but, unfortunately, their employment in engines used for model speed boats introduces an unexpected disadvantage, to which I have often referred in the past. Such engines, in their hectic aquatic adventures, are often liable to take in a charge of water, which more than fills the combustion space of the cylinder and thereby forms a

hydraulic lock, stopping the engine dead. The flywheels, when running at high speed, store a very considerable amount of kinetic energy—capable, in some cases, of producing an instantaneous effort equal to as much as ten times engine power—and it is easy to see that the effect of this is almost certain to be catastrophic; as indeed it has proved to be on several occasions, when boats having engines with internal flywheels have capsized.

My advice to constructors of speed boat engines who wish to emulate the excellent precepts of motor-cycle engine design in their miniature engines, is that this particular feature should not be too slavishly followed; but if used at all, the size and weight of the internal flywheels should be much reduced, and supplemented by an external flywheel, fitted friction-tight on the shaft. This not only helps to reduce the risk

mentioned above, but also enables the size of the crankcase to be kept more manageable, in view of the limited height of shaft centre usually permissible in a boat.

It is, of course, clear that an external flywheel, if rigidly fixed by keys or splines to the shaft, will be equally capable of wrecking the engine in the event of a sudden stop; this indicates the

necessity for providing some means by which it can be allowed to slip in the event of abnormal torque load. In my own case, the normal method of fitting the flywheel to a taper on the shaft, or a loose taper collet, has proved quite satisfactory, and the elaborate methods which have sometimes been suggested, such as a slipping clutch or a shear pin, do not appear to be necessary, and may prove more trouble than they are worth.

Incidentally, this may serve as an answer to some of my critics who have condemned as unsound practice the omission of positive timing location devices in the flywheel magnetos which I have recently described in *THE MODEL-ENGINEER*. It is much easier to re-time a magneto than to rebuild an engine!

### Variations on Motor-cycle type Crankshafts

The method of fixing the shafts in the crank discs, as employed in motor-cycle engines, demands extremely careful fitting, and some constructors have failed to produce a sound shaft when adopting this form of design. One great difficulty, if one attempts to make a scale replica of a motor-cycle crankshaft, is to obtain an adequate length of taper or thread on the shafts; it is very much better to make these considerably out of scale, in which case the thickness of the discs and the distance between

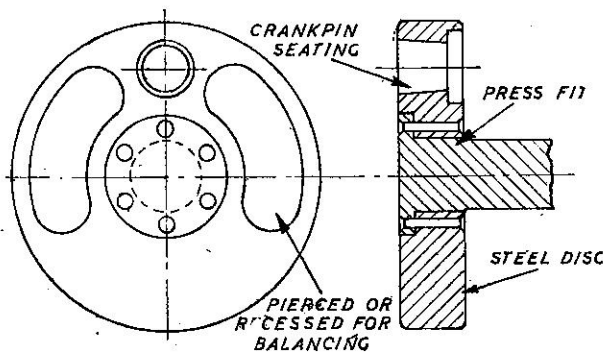


Fig. 14. Crank disc secured to shaft by a riveted flange

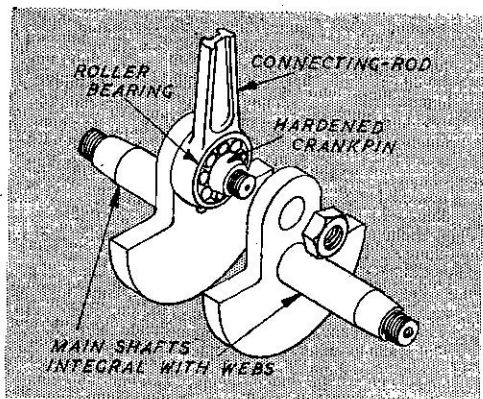


Fig. 15. A form of three-piece crankshaft popular in two-stroke motor-cycle engines

the main bearings must be increased to an extent which is often undesirable.

So far as the main shaft journals are concerned, it is possible to save end space by substituting for the taper and nut a riveted flange, as shown in Fig. 14. This may not only be used for both the main journals, but also for one end of the crankpin, as it is only necessary to be able to detach one web to assemble the connecting-rod eye. The riveting of the flange produces practically a permanent joint, that is, not suitable for dismantling in normal overhaul or servicing. When fitting a journal in this way, it is advisable to make the journal a press fit in the bore of the web, and the rim of the flange a "spigot fit" in a recess in the web; the rivets should be a close fit in their holes.

Where the diameter of crankdiscs is not excessive, it may often be found most practicable to machine each of the main journals and crankdiscs in one piece, thus forming a three-piece assembly, with the crankpin either tapered and nutted both ends, or with one end flanged and riveted. An alternative method would be to fabricate the web and main journal permanently by brazing. This method is quite suitable in all cases where it is not necessary to provide for hardening the main journals; as, for instance, when they run in ball races. A shaft of this type, having plain main bearings and a roller-bearing big-end, is fitted to

a well-known motor-cycle engine. The principle of construction is shown in Fig. 15.

### "Maneton" type Crankshafts

A form of crankshaft which is suitable for most types of model petrol engines is that comprising a main and subsidiary component, the former taking most of the load, and the latter forming a follower which is mostly used for driving timing gear or other auxiliaries, but may be found capable of taking the main drive, provided that it is well supported in its bearings, and subjected only to steady torque load.

This form of crankshaft (illustrated in Fig. 16) was used in the early days of rotary aircraft engines, and is still employed extensively in modern radial engines, as in this case also, it facilitates and simplifies both the design and assembly of the crankpin bearing, which in these engines is formed in the eye of the master connecting-rod.

I have used crankshafts embodying similar principles of design in several of my engines, including one which was developed some years ago in conjunction with the late Mr. F. Ford; all have been highly satisfactory in service. The subsidiary shaft was in this case attached to the crankpin by a taper and nut. A logical development of the "Maneton" type crankshaft is the addition of a follower shaft to a more or less normal form of overhung crankshaft, the subsidiary follower shaft having in this case only a light duty, such as driving the contact breaker or rotary admission valve, as in several of my two-stroke engines. Rigid connection of the follower to the main shaft is then unnecessary, provided the main shaft has adequate bearing length and structural strength, and the follower crank web need only have a hole or fork to engage the end of the crankpin, being thus self-aligning and flexible within certain limits.

### Clamped Crankpins

In the case of a two-piece or three-piece crank-

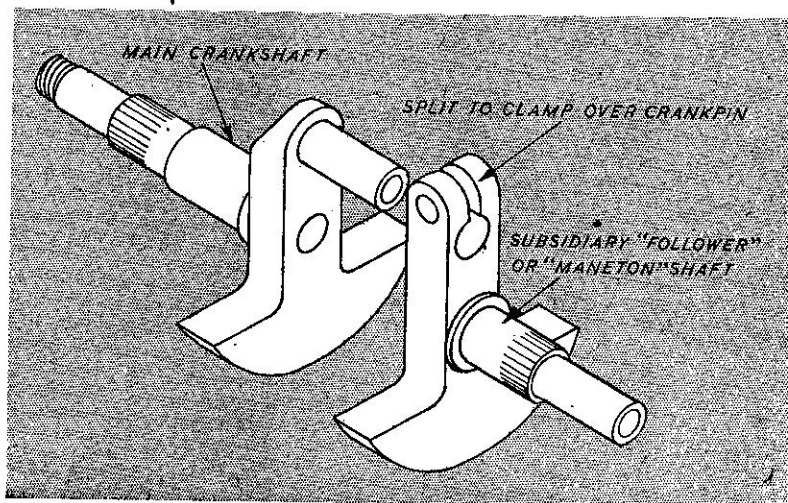


Fig. 16. Two-piece crankshaft having main and subsidiary components, as used in radial aircraft engines

shaft of any kind, one or both ends of the crankpin may be secured in the eye of the web by splitting the latter and fitting it with a pinching bolt. This method of fitting is shown in the Maneton shaft illustrated in Fig. 15, the bolt being in this case fitted outside the radius of the crankpin. One disadvantage of this form of construction is that it necessitates a rather large sweep radius for the crank web, which is not only inconvenient in some kinds of engines, but in two-stroke engines, increases crankcase volume and thus lowers pumping efficiency. Another point which arises in engines which have to run at very high speed is that centrifugal force on the crankpin makes it very desirable to have solid metal on the outside of the eye in the web.

It is possible to fit the pinching bolt on the inside of the crankpin, and in this way the web may be clamped simultaneously on both the crankpin and the main journal by a single pinching bolt. The snag in this form of construction is that the bolt-hole through the edge of the web must inevitably weaken it, so that the web must be made wider than would otherwise be necessary; but this also helps to ensure an adequate length of bearing for the crankpin ends, and thus resists any tendency for them to be forced out of truth. If the bolt is located so as to partially intersect the crankpin, it will form a

eccentric boring of the crank-web eyes, both of which must obviously be set out to exactly the same radius to ensure that the journals are correctly in line on assembly and that the crankpin is parallel to their axial centre line. Any attempt to rely on marking out the radius of the crankpin is almost certain to be futile; the exact coincidence of the radius of the pair of webs must be ensured by positive means.

The most satisfactory method which I have found so far in boring the eyes of the webs is to use an eccentric turning fixture, such as described for machining the crankpin of an overhung crankshaft. (See Fig. 8, March 21st issue.) Even so, it is most essential that the rough-turned journals should be parallel, and should fit the fixture closely. If a Keats vee angle-plate, or other vee-block fixture, is employed, any variation in the diameters of the two journals will obviously result in a variation of the throw radius. Needless to say, the fixture must be firmly clamped to the faceplate at its determined eccentric setting, and the utmost care taken to avoid disturbing it between the machining operations on the two webs.

Should it be found after assembly that there is a difference in the throw of the two halves, due to inaccurate setting up, it is useless to try to correct matters by machining up the main journals

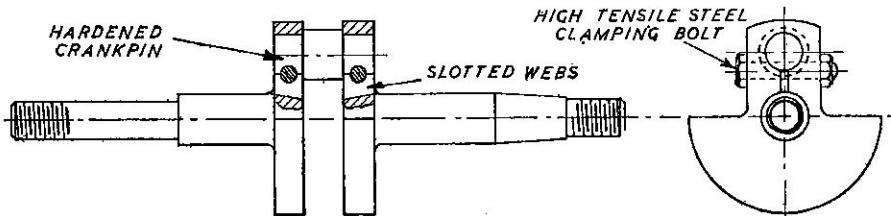


Fig. 17. Three-piece crankshaft with clamped crankpin

key to hold the assembly true in an angular sense, but this calls for the utmost care in the initial machining and fitting, and instead of ensuring accuracy, may have the opposite effect of perpetuating an error. (Fig. 17.)

In shafts which do not have to withstand a heavy duty, I have obtained highly successful results by securing and locating the pins in the webs by taper pins, disposed across the webs so that their centre line coincides with the tangent of the crankpin, in the same way as the bolt shown in Fig. 17. This ensures the maximum length of shear line, and also produces a wedging action on the crankpin, which is a moderately tight press fit in the web. While I have encountered very little trouble with shafts held together in this way, in the particular engines in which they were employed, I should not be keen to recommend the method for high-efficiency engines.

### Machining Built-up Crankshafts

One reason for the limited popularity of the built-up crankshaft is because many constructors have failed to make them satisfactorily, either in respect of initial accuracy or structural strength. The most important factor in success is, undoubtedly, correct method, particularly in the

*in situ*, by placing the assembly between centres. While this will undoubtedly put the main journals right, it is obvious that the crankpin will not lie parallel to them, and such a shaft could only work with a very sloppy big end, resulting in very poor mechanical efficiency.

Both the eyes in the webs, and the ends of the shafts which fit in them, should be highly finished, and fit accurately. This applies both to parallel and taper-fitted joints. Taper bores in the webs should never be *formed* with a taper reamer, though if a good reamer is at hand, it is an excellent tool for *finishing* them by taking out the merest scrape of metal to remove the marks of the boring tool. The ends of the shafts, if tapered, may finally be fitted with the aid of a superfine file, but parallel shafts should be lapped with a ring lap to a "wringing fit" in their seatings.

Where split clamping methods are employed, any slack in initial fitting will not only affect secure fixing, but also introduce inaccuracy, as the shaft will be forced over to one side of the eye. Just as much care should be exercised in fitting the pin to the eye as in the case where the latter is solid.

It is not always easy to be quite sure of exact endwise location of taper-fitted pins, owing to

the amount of draw being indeterminate, so it is best to allow for this in design, by providing some means of taking up end play by shims or other methods of adjustment. A little end float is usually permissible on the crankpin, and perhaps on the main bearings as well, though sometimes undesirable on account of noise.

It is, of course, necessary to "clock up" the shaft after assembly; in motor-cycle practice, alignment devices have sometimes been provided to facilitate assembly, but I have not yet found any device which will line up a model petrol engine crankshaft sufficiently accurately. The clamping nuts must be very firmly secured—though it is neither necessary nor desirable to screw them up to bursting point—and some means of retaining them from slackening off should be provided. Common expedients, which may be effective though crude, are burring over the screwed ends of the shafts, or sweating on the nuts with soft solder; they have the disadvantage of making subsequent removal

very difficult, and it is much better to go to the trouble of providing keep washers to lock the nuts.

Detachable crankshafts are sometimes objected to on the grounds that they are liable to go out of truth. I have not found them to give any trouble in this respect under normal conditions of working—always assuming that they are soundly designed and made—but if a crankshaft gets a really bad wrench through some abnormal cause, neither a built-up nor a solid shaft will escape some distortion. In such an eventuality, the built-up shaft may prove to be the better off of the two, because it is possible to set it true again, whereas a twisted crankpin in a one-piece shaft is almost impossible to correct satisfactorily.

A good deal more might be said about the design of crankshafts, but this series of articles is concerned more with the ways and means of producing them in a satisfactory manner, and with the facilities normally available to the model engineer.

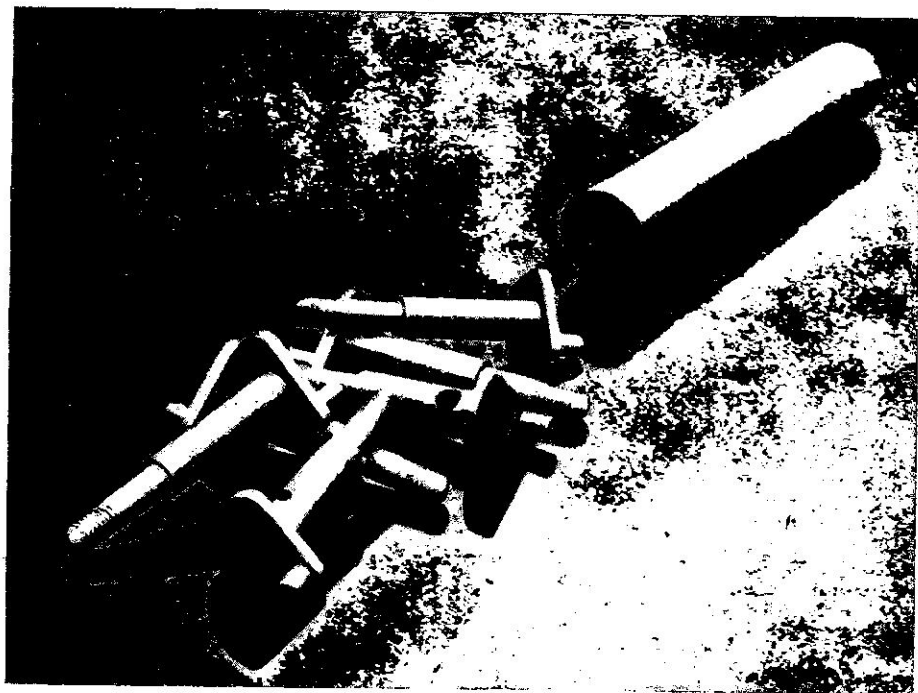


*Photo by]*

*[J. H. E. Rodgers*

**A batch of model crankshafts machined from billets like the one shown**

ON the suggestion of a friend of mine, I have made a drawing to show what the *Precedent* class looked like when brand new—that is, what I should term, their “phase 1.” Not so very different from *Hardwicke*, you may think on a first inspection. And yet, a second scrutiny reveals some little touches which I hope may take the L.N.W. enthusiast back to the days when the black engines, which we all knew so well, were making their first appearance on the premier line. In dimensions there was but little change. The outstanding one was that of the wheels, at first only 3 ft. 7½ in., and 6 ft. 7½ in. respectively in diameter. This was due to the thinner tyres originally fitted. In turn this lowered the footplate above the rail level down to 4 ft. 0½ in., and the boiler centre line likewise to 7 ft. 4½ in. It was a strange Crewe custom that wheel diameters were only quoted to the

things were looking good, when my eye fell on a lovely photo of *Sir Hardman Earle*, which I had placed at the side of my drawing board. (N.B.—Always have a photo of the engine you are modelling handy—she *may* be just the one that had some unusual fitting on her.) And when I looked at this photo, I knew I must begin to add the odds and ends. Rather reluctantly, I continued my work—but, after all, she does look rather fine, doesn’t she? I like the handrail higher up on the boiler side. That seems to be the right position for it. Do you notice that the driving splasher carries no shield—the splendid piece of gay heraldry which the impious dubbed a “cauliflower”? After No. 890 was turned out, Webb added this decoration to his black livery.

The initials L. N. & W.R., and words “Crewe Works” on the number plate were painted over in the red of the background; later they were

## LOCOMOTIVES WORTH MODELLING



### No. 13—L.N.W.R. No. 890, *Sir Hardman Earle*

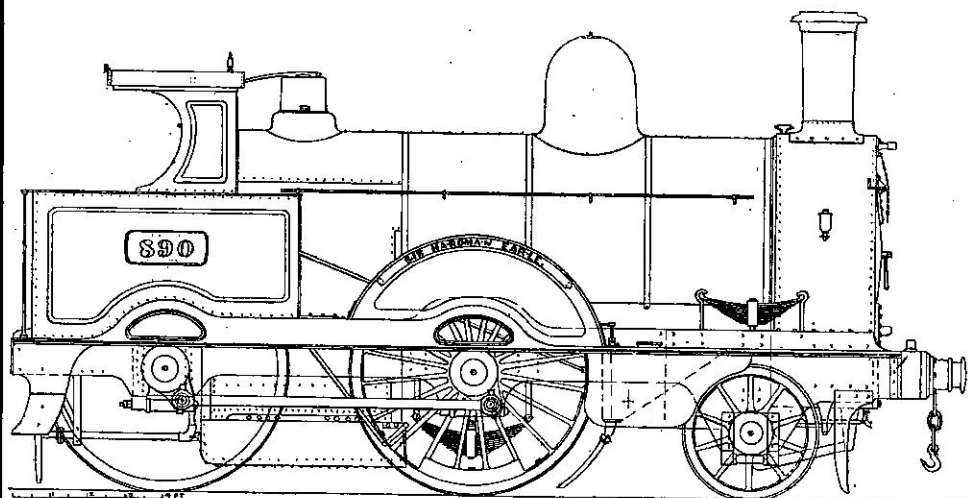
nearest 3 in. Thus the *Precedents* were “six-foot-six engines,” although not one of the gallant 166 ever had wheels of that size.

From the model-maker’s point of view, there is much to be said for the “phase 1” appearance of these first 70 engines. Apart from the historic aspect that I have already mentioned, there was, at least to my eye, a simplicity which seemed, in some manner, to set off the beautiful proportions of our old friends. I felt this very much as I made the drawing. The first setting out of the wheels, frames and boiler outline revealed a kind of beauty which comes at the early stages of a drawing. Indeed, one of my favourite pastimes was to make skeleton scale elevations of locomotives. Not like those tiny “weight diagrams” which the companies produce, which are rather cluttered up with dimensions and arrows and particulars (admittedly essential, but all the same, decidedly distracting to the eye), and which, curiously enough, often have details drawn very crudely as regards outlines. No, I mean something on the grand scale, say a foot to the inch. Try one and see for yourself. Only, to get the best fun out of it all, avoid putting in too much detail. A large, empty drawing of this kind gives one the feeling of looking at the actual thing—and that, I suppose, is what prompts us to model our locomotives.

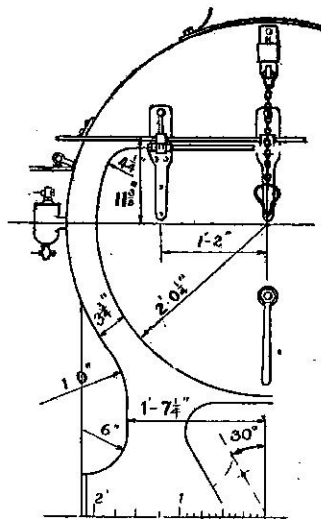
Well, I had got to the “empty” stage in the particular drawing under consideration, and

polished brass. At the side of the firebox (above the footplate), can be seen two rods, the upper one actuating the cylinder cocks, the lower one the ashpan damper. The upper rod was always retained on these engines, but the lower one was subsequently removed. This occurred when the ashpan was made shallower to give clearance for the pull-rod of the engine steam-brake. In its place was a damper rod that ran horizontally (just above the ashpan bottom level) from the damper to the rear, where a bellcrank turned its direction vertically, and so up into the cab on the fireman’s side (right-hand). The blower valve was originally on the driver’s side of the smokebox, his handrail being continued forwards to actuate the same. This valve was something like the standard cast-iron one of later days, but its gland was of polished brass with four turning slots in it. The gland nut which screwed into it was also polished.

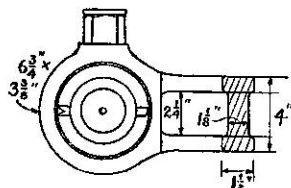
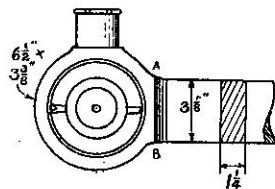
The smokebox door was of the old Ramsbottom type. It was slightly dished, with a very graceful curve, was fitted with three hinges, and opened upwards. There was only one fastening handle. When the smokebox needed attention, the door was held well above the horizontal by a chain attached to the top lamp socket. I often wondered why Webb changed this type of door. It was simple and convenient. Anyhow, he used it for the first twelve years of his rule at Crewe at least, and it had served previous to that for another



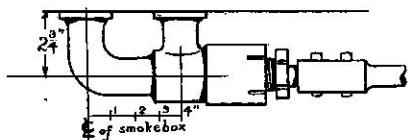
*How lovely the "Precedents" were in their first phase! Later on they could be seen fitted with brake blocks between the driving wheels*



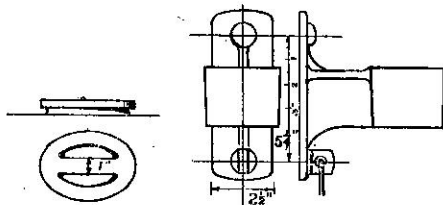
*The Ramsbottom door as fitted to the "Precedent" class*



*The old coupling-rods were black as far as the line AB. The end was polished. The newer fluted rods were entirely bright*

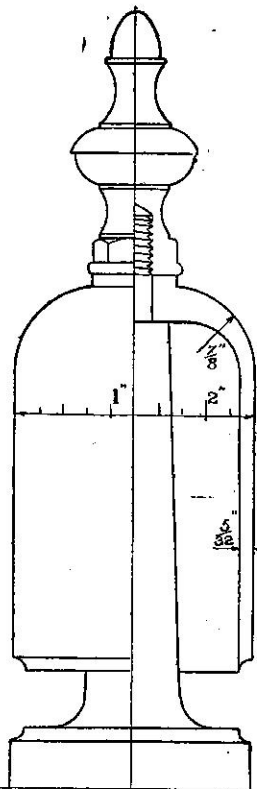


*Plan of blower-valve, which was placed on the left-hand side of the smokebox*



*Standard sandbox lid, and top lamp-socket for smokebox*

fourteen years! At the base of the chimney was a round plug type of lubricator for supplying oil to the regulator valve, which was situated in the smokebox. These lubricators disappeared also about the same time as the abolition of the old smokebox door. Another link with the past was the chain and hook fitted to the front buffer-beam hook. This also was the same as those fitted to the Ramsbottom engine. Needless to say, there was no front vacuum hosepipe—there wasn't even any brake on the engine itself! It seems likely that the fireman must have had a hard time of it when trying to hold his train by the tender brakes alone, for these had only very slight wooden brake-blocks, and his handwheel was a wretchedly small  $13\frac{1}{2}$ -in. wheel with a thick  $1\frac{1}{2}$ -in. rim, which made it uncomfortable to manipulate. Much the same could be said of the rod, with its "eye" at the end for working the water-scoop. But men were tough, and speeds were low, although how they managed to handle these things and keep their bowler hats on in the breeze at the same time must remain one of the major mysteries of life! On the sides of the smokebox were small displacement lubricators feeding into the steampipe. This fitting



*The Webb whistle*

was abolished when the "Jumbos" were given sight-feed lubricators. They were painted black with polished brass nuts and taps top and bottom. The sandboxes, hidden behind the shapely outer plate, were quite large. Their filler lid was elliptical, measuring 8 in. by 6 in., and was dished inwards, which allowed of a handle being cast across the top. Two sand levers were mounted on a shaft in the cab—one lever for each man. The shaft was carried in bearings cast on the fire-door casting, and ran horizontally above and across the fire-door, the levers themselves standing vertically at the firebox sides in a very convenient position. Both Gooch's broad-gauge singles, and Stirling's eight-footers had the same arrangement.

The driving wheels had laminated springs, whilst the rear pair had a transverse plate spring placed above the rear axle and bearing on a casting below the footplate. It was, therefore, quite out of sight.

And now, how do you like my beauty? As much as I do, I hope, and we only need a drawing of the cab fittings and the tender to complete what must necessarily be a short description of one of the finest classes of locomotive ever built.

## FOR THE BOOKSHELF

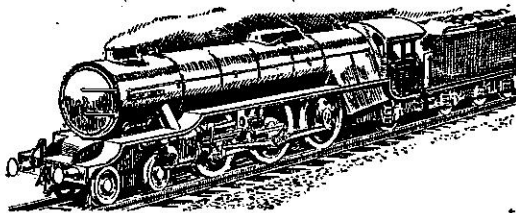
**Narrow Gauge Railways of Ireland**, by H. Fayle (London: Greenlake Publications Ltd., 156, Camden High Street, N.W.1). Price 17s. 6d. net.

This is a cloth-bound volume of some 200 pages, and it seems destined to become a classic of its kind. Its production is excellent, and its contents can hardly fail to be of absorbing interest to the great many railway enthusiasts whose chief study is the sub-standard gauge line. Very numerous illustrations include half-tone reproductions, line drawings, maps and gradient profiles, while the text is clearly printed, informative and obviously the work of a painstaking researcher. The pictures and lists of dimensions of the locomotives should be useful to many of our readers; but several examples of other kinds of rolling-stock are dealt with in some detail, enhancing the scope and interest of this book.

Railway literature has been worthily enriched by the addition of this outstanding little volume.

**The Uppingham Twelve-inch Tunnel**, by G. W. Gregory (Leicester: The Harborough Publishing Co. Ltd., Allen House, Newarke Street). Price 25s. 0d. net.

This is something of a novelty, as regards technical publications, in that it consists of 30 foolscap roneoed sheets of reading-matter, six pages of art paper for half-tone illustrations, and two large sheets of drawings reproduced full-size. In these days of aerodynamics, singularly little information is available to the amateur constructor who might wish to build himself a wind-tunnel in which to carry out experiments. This elaborate brochure appears to supply much of the hitherto missing data.



# "HIELAN" LASSIE"

By "L.B.S.C."

**T**HOUGH not particularly in favour of the type of guide bar and crosshead used on the Gresley engines of the L.N.E.R., I am specifying a slightly simplified version of that particular pattern, in order to please friends and relations of Inspector Meticulous. Personally, I'd rather have double bars with a big alligator crosshead, or the hefty single bar beloved of Jimmy Holden and Billy Adams, with its "Bill Massive" type of box crosshead. I just about had enough of guide bars of the weeny-weeny pattern when fitting up the proper kind to the outside cylinders of my Webb compound *Jeanie Deans*; but I got my own back all right with the pair installed inside to guide the low-pressure crosshead, as you'll see if I can get some pictures of her. However, to business.

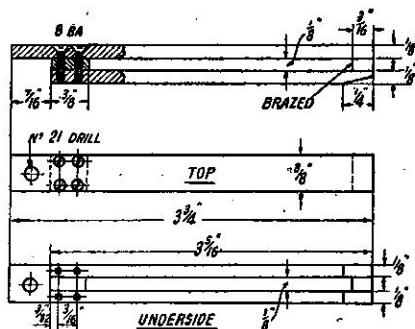
The same assembly does for all three cylinders on the "Lassie," each consisting of a wide top bar which takes the strain when running forward, and two smaller ones below it, between which the crosshead slides. The top bar is made from a piece of  $\frac{3}{8}$ -in. by  $\frac{1}{2}$ -in. flat steel—silver-steel is best—squared-off at each end to a length of  $3\frac{1}{2}$  in. The two lower bars are made from  $\frac{1}{2}$ -in. square silver-steel, cut to a length of  $3\frac{1}{8}$  in. There is a distance-piece at each end, one of which has to be made removable, or you won't be able to get the crosshead in position; that at the cylinder end is a  $\frac{3}{8}$ -in. length of the same kind of steel used for the top bar, and the one at the other extremity is a piece of  $\frac{1}{2}$ -in. by  $\frac{1}{2}$ -in. steel,  $\frac{3}{8}$  in. long. At  $3/32$  in. from one end of each of the shorter bars, make a centre-pop and be sure you get it dead in the middle; then make another,  $\frac{1}{16}$  in. farther along, taking the same strict caution as before. Drill these out with a No. 51 drill. Now carefully assemble the three bars together, as shown in the illustration, with the square distance-piece  $\frac{1}{16}$  in. from one end of the top bar and the narrow bars spaced so that a piece of steel  $\frac{1}{8}$  in. wide can slide between them from end to end. Hold the assembly with a couple of small toolmaker's cramps whilst doing this; then, when O.K., continue drilling the No. 51 holes through distance-piece and top bar. Next, take them apart, open out the holes in distance-piece and top bar with No. 43 drill, and countersink those in the top bar. Tap the holes in the narrow bars 8-B.A. then re-assemble, using four  $\frac{3}{8}$ -in. by 8-B.A. counter-sunk screws to hold the bars together. Place the narrow spacer in position at the other end of the bars, flush with the ends, and wind a piece of iron binding-wire tightly around, just clear of the spacer, to hold the bars together and prevent the spacer from slipping; then braze or silver-solder the spacer in position. Just put a smear of flux around the joints, heat

to red, and touch with a bit of soft brass wire, Sifbronze wire, or silver solder. Quench in water, and clean up; then file the  $\frac{1}{4}$ -in. by  $\frac{1}{16}$ -in. bevel at the ends of the narrow bars, to allow the connecting-rods plenty of clearance. In the middle of the  $\frac{1}{16}$ -in. gap at the cylinder end, drill a No. 21 hole, to take a  $5/32$ -in. screw for securing the assembly to the top of the gland bosses on the cylinders; but don't fit them yet, for reasons which you'll know later.

## Crossheads

When scheming out the crossheads, the grey matter was joggled up a bit to see if there were any chances of an exact copy of the full size articles; but, unfortunately, Nature still refuses to be "scaled," so we had to fall back on the single-sided crosshead with the big-headed pin which forms the other side. Incidentally, this is not one of my own ideas, but was suggested by my old friend Mr. F. A. Tye over 25 years ago. The advantage is not only ease of manufacture, but perfect support to the little-end of the connecting-rod, and no projection on the inside to run foul of the coupling-rod bosses. The same pattern of crosshead is used for both inside and outside cylinders; the inside crosshead is made the same as that for the left-hand outside cylinder, except that the recess is pin-drilled  $1/32$  in. deeper, and the head of the pin made  $1/32$  in. thicker, to bring the centre of the connecting-rod in line with the centre of the piston-rod. The outside connecting-rods are slightly offset, to allow extra clearances for other moving parts.

A piece of 1-in. by  $\frac{3}{8}$ -in. mild-steel bar about 3 in. long will make all three. Mark-off the position of the grooves,  $\frac{1}{8}$  in. from the edge; the grooves are  $\frac{1}{8}$  in. wide and  $\frac{1}{8}$  in. deep. On a regular milling-machine, the bit of rod is simply held in the machine-vice on the table, and the groove taken out at one fell swoop by a  $\frac{1}{8}$ -in.



Guide-bars

slotting-cutter on the arbor. Incidentally, I never bother about marking-out things like these—Curly *would* do it “the wrong way,” or it just wouldn’t be Curly!—and just to make you smile, I’ll tell you how the fairies from the bottom of the garden do it. First put the cutter on the spindle, then set the cross-slide so that the fixed jaw of the machine-vice touches the cutter. The cross-slide handle is then turned one-and-a-quarter turns, which moves the fixed jaw away from the cutter exactly  $\frac{1}{8}$  in. The table is then lowered a bit, and the piece of bar put in the vice, level with the tops of jaws. One fairy then pulls the belt by hand, whilst another one turns the handle which raises the table, until the teeth of the cutter just scrape the surface of the piece of bar. The table is then moved longitudinally by turning the feed-handle until the bit of bar is clear of the cutter; then the table is raised  $\frac{1}{8}$  in. by turning the elevating handle two-and-a-half turns. The motor is then started, oil from the drip can turned on, self-act clutch engaged, and “Milly Amp” proceeds to do the job all on her own, whilst the other fairies get busy on something else! When the whole length of the bit of bar has passed under the cutter, the automatic table stop knocks out the clutch, and the machine just idles until switched off. To cut the second groove, the bit of bar is simply turned over, placed level with the tops of the vice-jaws again—the table being, of course, wheeled back to starting position—and the operation repeated. Both grooves are then found to be dead to size and dead in line, and the foreman fairy seldom has occasion to use any of the particular variety of Esperanto she learned when sergeant-major in the A.T.S.!

The job can be done in similar manner in an ordinary lathe, if a cutter is available; mount it on an arbor or spindle between centres and bolt the machine-vice to the saddle. Mark-out the piece of bar, and set it in the machine-vice so that the marks are lined up with the cutter, and the surface of the steel  $\frac{1}{8}$  in. higher than the bottom of the cutter. Now traverse the cross-slide slowly, using the slowest lathe speed and plenty of cutting oil, and the groove will come out all right; for the second one, simply turn the piece of bar over, and re-set at right height. The grooves can also be cut out by a  $\frac{1}{8}$ -in. slot-drill or end-mill in the three-jaw, in exactly the same manner as described for axleboxes. The piece of bar, after grooving, is sawn into three; each one is chucked separately in the four-jaw, and the ends carefully faced off so that each piece is exactly  $\frac{1}{2}$  in. long.

On the vertical centre-line of each piece, and  $\frac{3}{8}$  in. from the lower edge of the groove, make a centre-pop, and drill a  $\frac{1}{16}$ -in. hole squarely through each, using either drilling-machine or lathe. Next, with a  $\frac{1}{8}$ -in. pin-drill having a  $\frac{1}{16}$ -in. pilot-pin, open out two of the holes in the cross-heads to a depth of  $\frac{1}{2}$  in., and the third to  $9/32$  in. The holes for the bosses can then be drilled in the end of each piece; use  $\frac{1}{8}$ -in. drill, and be sure they are exactly on the same centres, and at right-angles to the pin-drilled holes, as shown in the illustrations. Take special care to have these right, otherwise you’ll have trouble with the guide-bars binding in the grooves

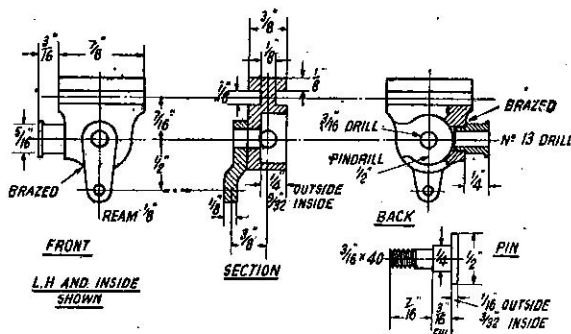
and probably the piston-rod won’t enter the hole in the cross-head boss. If you hold the cross-heads in a machine-vice, with the edge to be drilled level with the jaws, the job can be done either on a drilling-machine or in the lathe, with drill in three-jaw, and vice held against a drilling pad on the rail-stock barrel, and the holes will be O.K. The lower part of each cross-head may then be filed to shape as shown, and a clearance filed in the side of each pin-drilled recess, to allow the connecting-rod to clear; see back view. When drilling for bosses, and filing to shape, don’t forget that one cross-head with  $\frac{1}{8}$ -in. recess is right-hand, and the other ditto is left-hand; the one with a  $9/32$ -in. recess, which is for the inside cylinder, is also made left-handed.

To make the bosses, chuck a bit of  $\frac{3}{8}$ -in. round mild-steel in three-jaw; face the end, centre, and drill about  $\frac{1}{16}$  in. deep with No. 13 drill. Turn down  $\frac{3}{8}$  in. length to  $\frac{1}{16}$  in. diameter, then further reduce  $\frac{1}{8}$  in. of the end to a tight squeeze fit in the holes in the ends of the cross-heads. Part-off a full  $\frac{3}{8}$  in. from the end, leaving a little flange of the  $\frac{3}{8}$ -in. rod to form the bead; reverse in chuck, and round-off the little bead with a file, with the lathe running fast. The bosses may then be squeezed into the holes in the cross-heads, using the vice as a press; or alternatively, the holes may be tapped  $9/32$  in. by 40, the ends of the bosses screwed to suit, and screwed home instead.

The cross-head arms are made from  $\frac{1}{2}$ -in. by  $\frac{3}{8}$ -in. flat steel rod, and being merely a simple filing job, need no detailing. They are off-set as shown in the section of cross-head, so that their centre lines are  $\frac{3}{8}$  in. from the centre line of the cross-head, in order to bring them in line with the combination-levers when the valve-gear is fitted. Note that the distance between the centres of holes is  $\frac{1}{2}$  in. after bending to shape. If anybody finds difficulty in bending a short thick piece to the correct off-set, use  $\frac{3}{8}$ -in. by  $\frac{1}{2}$ -in. rod, and file or mill the bend out of the solid; but you can bend two arms at once in the vice if you go to work in the following way. Put a bit of  $\frac{1}{2}$ -in. by  $\frac{3}{8}$ -in. between the vice-jaws, with packing-pieces each side, as shown in the plan sketch, and then swing the handle, and the bit of metal promptly curls up! Sawn in half, it makes two nobby cross-head arms.

The arms are brazed to the cross-heads. To hold them in position whilst this operation is in progress, drive a  $\frac{1}{2}$  in. of  $\frac{3}{8}$ -in. copper tube into the hole in the cross-head arm, and insert the projecting bit into the hole in the cross-head, setting the arm at right-angles to the grooves in cross-head. If the tube is loose in the hole, expand it with the business-end of a centre-punch applied to the ends of the tube, and a little persuasion from a hammer will do the trick. The joint is then brazed, as previously described for these small oddments, and the bit of copper tube drilled out with a  $\frac{3}{8}$ -in. drill. Whilst brazing on the arm, run a little filler around the boss at the same time, whether pressed or screwed; and when the whole issue is cleaned up, it will be as good as if cut from the solid.

Turning the cross-head pins is a kiddy’s practice job; chuck a bit of  $\frac{1}{2}$ -in. mild-steel



Crossheads

rod in three-jaw, face the end, turn  $\frac{3}{8}$  in. length to  $\frac{1}{4}$  in. diameter, further reduce  $\frac{1}{16}$  in. length to  $\frac{1}{8}$  in. diameter, and screw about half of it  $\frac{1}{8}$  in. by 40. Part-off two pins with heads  $\frac{1}{8}$  in. in thickness, and one with a head  $\frac{3}{32}$  in. thickness. The latter goes into the cross-head with the  $9/32$ -in. recess in it. Ordinary commercial nuts won't do as they are, because they have coarser threads; make the three special nuts from  $\frac{1}{4}$ -in. hexagon steel, or else use  $5/32$ -in. commercial nuts with the old thread drilled out and re-tapped  $\frac{1}{8}$  in. by 40.

### Outside Connecting-Rods

The outside connecting-rods are made exactly the same as the coupling-rods, as far as machining and fitting are concerned, so we don't have to detail out all the rigmarole again. The sizes are given on the illustration. Two pieces of steel,  $6\frac{1}{2}$  in. long,  $\frac{3}{4}$  in. wide, and  $\frac{1}{4}$  in. in thickness, are needed for the job, and they are marked, drilled, and generally operated on as already described. Note, the big-end bush projects  $1/32$  in. from the plain side of the rod, to keep the boss clear of the coupling-rod when the whole issue is erected. The little-end bush is flush both sides. I have shown a parallel flute, although the rod is tapered, as it is easier to mill than a tapered one, though the Inspector's followers can make it taper if they like to take the trouble. Probably others might care to use a plain rod without any flute at all; but a fluted rod looks pretty, I freely admit, and fit them to my own engines, although Billy Stroudley used plain rods and painted them. Next job, inside connecting-rod.

### Another Spot of Horology!

You never know what you can do till you try! Your humble servant was amused when a recent contributor of some excellent articles on watchworks, wondered why I said "ugh!" to watch-making jobs; and opined that it was not because I couldn't do them, but just didn't like them. As a matter of fact, I have never been interested in watchmaking, although two of my few personal friends, Messrs. McDowell and Rummens, are fully-qualified experts; but anyway, when the watch-sized hair-spring of the clock on my gasoline cart broke, I managed to fix it all right, though it wasn't exactly "ugh!" that accompanied the process! However, I have not

hitherto shied at tackling clockworks; readers who recollect my reminiscences of the munition shop may remember—

There was a young lady named Kate;

Five mornings a week she was late;

She said "If I fix

The alarm clock for six

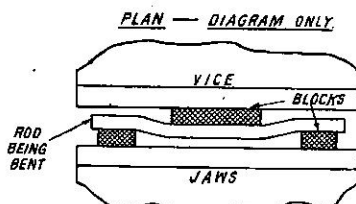
It usually rings about eight!"

And so I fixed it for her, and she duly kept time; but the next morning I found eight alarm clocks in the office, all needing attention!

Well, about sixteen years ago I bought a small chiming clock to adorn our living-room mantelpiece, and it went very well, even through the 1940 blitz, and right up to the time the doodle-bugs started operations. The day we

temporarily abandoned home, it was still going strong, and one of the last things I recollect about that day, was hearing it chime as I shut the door, and wondering if I would ever hear it again. Whether it became sulky at being left to its fate, I don't know, or whether some of the near-misses that occurred whilst we were away upset its internal anatomy, I'm not quite certain; but the fact remains that when we returned, it didn't behave nearly so well as before, varying in speed, and occasionally emitting sundry bumps and other strange noises. A few weeks ago it started stopping, as Mike O'Finnegan would remark; or perhaps as Tommy Handley's Welshman would say, "Intee to gootness it went on strike and wouldn't strike at all!"

Anyway, my fair lady said "What was I going to do about it," so I pulled the works out of the case, and was a bit dismayed at the conglomeration of wheels, spring barrels, and various blobs and gadgets (I'll say they were all that!) comprising



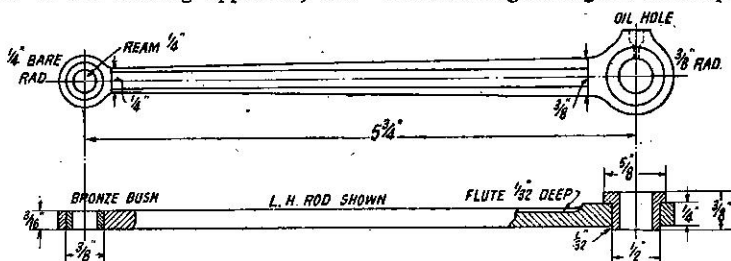
How to bend crosshead arms

the clock's giblets; but then I recollected that the party who built the finest little locomotive I have ever seen, to wit, Dr. J. Bradbury Winter, was also a past-master in "clockology," and had made some marvellous specimens, so surely Curly shouldn't shy at trying to repair one that was quite simple in comparison. Thus stimulated, I examined it, and found that the escapement spindle bearings were badly worn, the pallet grooved by the wheel teeth, and several more little evidences of the effects of anno Domini; so after taking a good mental photograph of the "valve-gear," I pulled it to pieces and got busy. The job was done in locomotive fashion, the worn holes in the side plates being drawn over by an amount equal to the wear, then drilled out, tapped a fine thread, and little bronze bushes screwed in. I got over the pallet

trouble by shifting it farther along the spindle, so that the teeth of the wheel engaged with a fresh surface; this saved having to make a new one. My old gramophone-repairing experiences helped with the springs, as I took them out, washed them in paraffin, and gave them a dose of ball-bearing grease before replacing in the boxes. I didn't have nearly the amount of trouble anticipated in getting the whole bag of tricks together again; but it was a bit of a game "setting the valves," or in other words, tuning up the chiming gear. I always thought chimes were operated by pegs in a drum, like the barrel of a musical box; but in this particular clock they worked by a group of star wheels. However, I managed to discover all the hidden secrets and mysteries of the chiming apparatus, and

was highly delighted when I turned the minute hand to "fifteen past," and the chimes promptly announced "quar-ter-past-three"!

A weeny spot of oil was finally applied to all the bearings, wheel teeth, and everything that moved, using a thin pointed wire; and then the whole lot was re-erected in the wooden case, hands put on, and pendulum adjusted for even ticking. When the clock was returned to its place on the mantelpiece, it started right away with a nice healthy "business-only-meant" tick; and it has never stopped since, chimes beautifully, and keeps within a minute of the pips of the radio time signal. As mentioned above, you never know what you can do till you try; but all the same I wouldn't care much about earning a living as a clock repairer—ugh!



Outside connecting-rod

## Model Engineering Put on the Map at Staines

A VERY successful first Model Exhibition was held at Staines on Saturday, March 30th, organised by the Staines and District S.M.E. & C., and supported by the Malden, Vickers, South London and Kent Societies, and lone hands around the district. The hall, by courtesy of the Staines Youth Club, was ideal for the purpose, and the day prior to the show was a hive of industry, the secretary and willing helpers arranging the exhibits ready for opening at 10 a.m. next day. By working until 3 a.m., this was accomplished, and next day saw the show on its way. A steady stream of people came and went until 2 p.m., when a real rush commenced, the hall being crowded from then on until closing down at 8.30 p.m.

Well over 1,200 people saw the show and among the crowd were many members from Malden, Godalming, Andover, Aldershot, Vickers, etc., and many expressions of appreciation of the show were made to stewards and officials. In a smaller hall, the Malden miniature cinema, operated by Mr. Bontor, gave performances each half-hour, proceeds being devoted to St. Dunstons.

The judges, Messrs. J. N. Maskelyne, Edgar T. Westbury and J. R. Austen-Walton (Malden), had a hard task judging the competition entries, and awarded the prizes as follows:—

1st.— $\frac{1}{16}$  in. Scale Model Traction Engine. Mr. G. Froud (Vickers).

2nd.—7 mm.-scale "Locomotive No. 1," 1825, Mr. Haslett (Staines and District).

3rd.—1-in. scale Adams Bogie Express Locomotive, No. 593, Mr. Gloyns (Malden).

The prize-winning traction engine was

described as a perfect example of scale modelling, as even the tiny lamps had oil containers and wicks. The judges commented on the high standard of workmanship displayed, and a 0-4 in. sensitive drill by Mr. Woodgate (Staines and District), and a 36 in. restricted class racing yacht by Mr. Wake of Vickers, were both "highly commended."

Outside the hall, Malden Society had erected a portable track, and "Mustang," Mr. Marshall's fine locomotive, gave something like 600 kiddies rides during the show period.

Many exhibits were of great attraction, including a non-working model motor-cycle, complete in all external detail; an "O"-gauge coal-fired locomotive "Windsor Lad"; a 6-in. Q.F. naval gun; a clinker-built 50/800 racing yacht hull; an experimental rotary engine, and a number of models were run under compressed air, including Mr. Austen-Walton's 5-in. gauge L.M.S. No. 5751, and "Stirling" single-wheeler owned by Mr. Wilson (Staines S.M.E. & C.). Tea and refreshments for stewards and officials were provided by wives of three of the members, and helped the smooth running of the show from the official angle.

Closing-time came all too quickly, and it was generally agreed that the effort expended in arranging the show had proved worth while, and that the local residents had been made aware that model engineering was something really important.

The support of local schools in the handicraft section must be mentioned, as we feel the youth of to-day are the craftsmen of to-morrow.

# A Simple Dial Indicator

By A. L. JACKSON

NO doubt many amateurs have sometimes wished for one of those handy little dial indicators, but have been stopped from buying one because of the high cost; second-hand micrometers can be obtained, but second-hand dial gauges are more rare than diamonds, so the amateur has to make do without, to the detriment of real accurate work.

The ordinary type of dial gauge, in which magnification is obtained by means of accurate cut gears, often running on jewelled bearings, is almost impossible to make without special appliances, but a very simple dial indicator can be made very easily providing one does not desire a pocket type size, that is not to say the dial must be six inches in diameter; quite a decent gauge can be made with a dial only three inches diameter, which is not so much larger than the commercial article.

Naturally, the work needs to be well done, a sloppy pivot, for example, can easily lose several thous. when it is magnified, and probably a skilful reader can adapt jewels from an old watch and so make practically an everlasting job; in just the same way friction is not desirable, so that polished pivots are very desirable; but apart from these small points there is nothing particular about the gauge to be described. Calibration

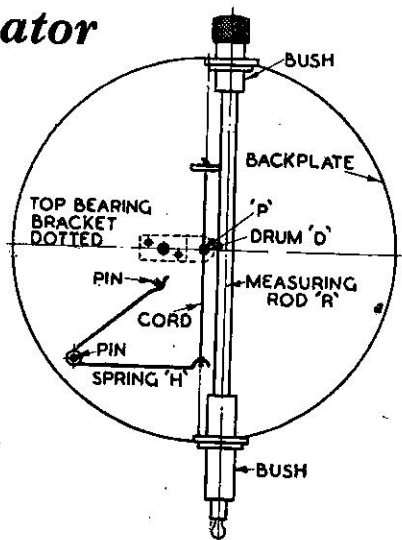


Fig. 1. Simple dial gauge

can be accomplished by setting the gauge up and inserting feeler gauges under the measuring point to raise it in steps of one thou. or even ten thou. and putting the intermediate marks in by hand; for the thicker pieces various odd scraps of material can be measured with a micrometer and used as distance pieces.

Now for the gauge itself. Some form of simple magnification is needed without using gears, worms, or any device difficult to make, and the whole thing must be as simple as possible to ensure reliability. The simplest form of magnification is a pivoted arm in which one end is, say,  $\frac{1}{8}$  in. long, and the other end is several inches long; naturally, a small movement at the short end will result in a large movement at the long end, and this idea is put into effect in a number of small indicators on the market; it has one disadvantage, that to get a large degree of magnification or a long scale it must be very large and awkward. A pointer moving over a 3-in. diameter dial traverses a length of just over 9 in., and if a measuring rod could be made to move  $\frac{1}{16}$  in. and cause the pointer to turn once, then each  $\frac{1}{16}$  in. on the dial would correspond to approximately one thou. Actually, it would be a little more than  $\frac{1}{16}$  in., and this can be done very simply.

Take a look at Fig. 1. Here will be seen our dial gauge with the dial removed, leaving the works exposed. At "P" will be seen the pivot carrying the hand, and on this spindle is fixed a small drum lightly knurled and  $\frac{1}{16}$  in. in diameter.

Passing slightly to one side of the spindle is the measuring rod, "R," carried in bearing at top and bottom, and

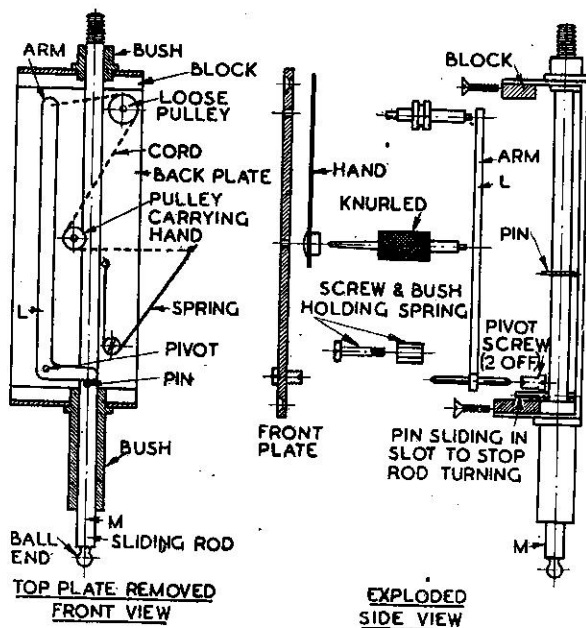


Fig. 2

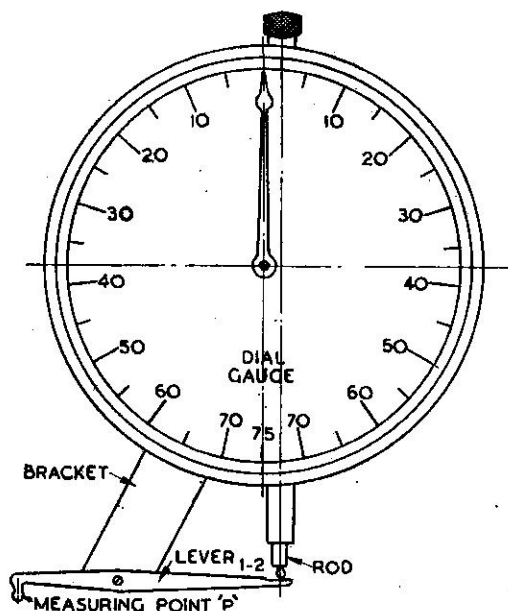


Fig. 3

fitted with a knurled knob at the top, as is the usual practice. In the back-plate is a slot, and a pin at the back of the rod runs in this slot to prevent the rod from rotating. At the bottom of the case is a hairpin spring, "H." From this spring passes a length of fishing line which goes several times round the drum, "D," and is attached to the pin at the top of the measuring rod.

When the rod is pushed up it pulls this cord and causes the drum to revolve; the spring merely serves to keep a tension on the cord and to return the measuring rod to zero.

In actual practice it will be found that if the drum is  $\frac{1}{16}$ -in. diameter, or just a knurled spindle,  $\frac{1}{8}$  in. movement of the rod will cause the hand to make one revolution and with a  $3\frac{1}{2}$ -in. dial will have 187 thou., spread out over a distance of nearly 11 in., or almost  $\frac{1}{16}$  in. to one thou. A larger dial would increase the spacing, but  $\frac{1}{16}$  in. is fairly reasonable with a moderate size dial.

The pivots must be kept fairly fine, and a needle with a thin tube soldered on and afterwards turned down to  $\frac{1}{16}$  in. and lightly knurled is excellent for this. The cord must be good fishing line, or it will stretch and upset the calibrations, and should have at least four turns round the drum to prevent any possibility of slipping; the hairpin type of spring seems better than the coil spring for a job of this kind. Make it as long as possible.

Compared with the commercial article, there are, of course, a few minor disadvantages; the magnification is not so great, and the size is greater, but to offset this is the fact that it is much simpler, requires no accurate gears, and can be made at home very cheaply. It is quite

suitable for a workshop comparator and could be made for this purpose with a larger dial giving a more open scale.

A fairly decent spring will permit two whole turns of the pointer, but the drum will need to be made to an accurate size, so that an even number of thousandths is spread over the dial or the second revolution will not be accurate. For ordinary home use one revolution will be ample.

Basically, that is the simplest type of dial gauge possible to make and can be used for quite a lot of work, but there are means of elaborating the idea and increasing the space per thousandth of an inch.

Fig. 2 shows a gauge in which this is carried out and it can be seen that in addition to the magnification from the drum and cord a lever is used as well and marked "L" in the sketch. A small free drum must be used to run the cord at right angles for the lever. With a lever  $\frac{1}{2}$  in. along one side and  $1\frac{1}{2}$  in. along the other side, there will be an increase of magnification of three,

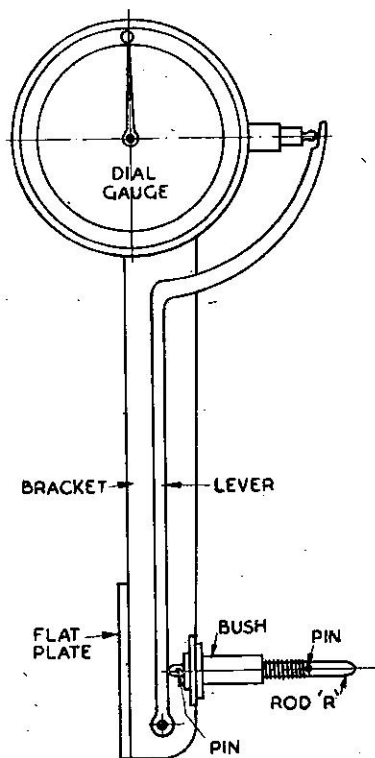


Fig. 4

which could be used to make a smaller dial possible, or greater spacing between calibrations; this gauge has one disadvantage in that the measuring rod travel is necessarily limited to a small amount, otherwise the angle of the lever will be altered too much and throw the accuracy out, but for  $\frac{1}{2}$  in. movement it should be quite all right.

(Continued on page 448)

# ★THE HANDYMAN

## 100 YEARS AGO

By G. A. GAULD

### III—The Crank in Disguise

WHILE the Battle of the Crank raged throughout the 19th century and engineers expounded their theories for and against it, the practical handyman was busy in his workshop devising substitute mechanisms with each of which, no doubt, he hoped to revolutionise steam engine practice. The list is a long one, but a description of a few representative examples will suffice to show the lines along which he sought to attain perfection.

Although the crank was known to the ancients and figured in the machines of the Egyptians, Greeks and Romans, I believe the first recorded invention for the purpose of converting the reciprocating motion of a piston in a cylinder to which steam was applied into rotary motion, to be ascribed to Johnathan Hulls. A description of the mechanism was set forth in a pamphlet dated 1737 and designed for the purpose of rotating a paddle or stern wheel to propel a ship by the power of steam. The engine is represented in Fig. 1.

Three pulleys, *a*, *b* and *c* are keyed to a common shaft; the stern paddle is keyed to another shaft, which also carries two loose pulleys *d* and *e* connected to the shaft through ratchets arranged to drive the shaft in the desired direction only. The pair of pulleys *c* and *e* are connected by a

\* Continued from page 246, "M.E.," March 7, 1946.

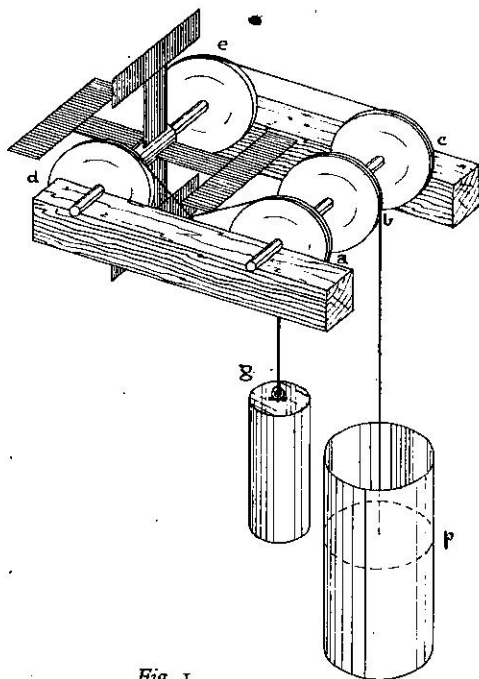


Fig. 1

direct belt or rope and the others, *a* and *d*, by a crossed belt. A rope is passed over the centre pulley *b*; to one end is fixed a counterweight *g* and the other end to the piston *p* of an "atmospheric" steam engine. Condensation of the steam below the piston draws it down and imparts motion to the paddle via the pulleys and ratchets and crossed-belt drive. As low-pressure steam is admitted to the cylinder, the piston is moved up with the assistance of the counterweight, at the same time, rotation to the paddle being transmitted via the direct drive.

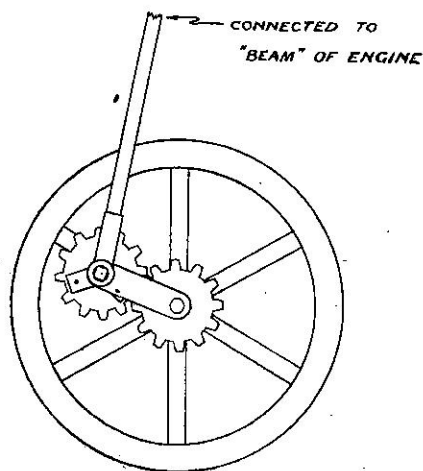


Fig. 2

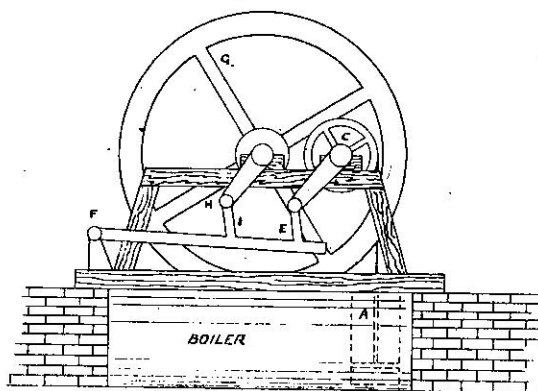


Fig. 3

The sun and planet motion became famous, because it was produced by James Watt. But it was really the crank in disguise, as doubtless he well knew. He patented and utilised the motion in 1781 as he was unable to use the crank by reason of a prior patent taken out in 1778 by Matthew Washborough, of Bristol, under the name of John Steed. One slight advantage possessed by the sun and planet motion, as will be seen by reference to Fig. 2, is that the flywheel makes two revolutions for each full cycle of the piston. This enabled Watt to use a lighter flywheel. He was, however, well aware of the superiority of the plain crank and as soon as Steed's patent expired, Watt discarded his own sun and planet motion in favour of the simpler movement.

Edmund Cartwright produced several mechanisms of which, perhaps, his portable "atmospheric" engine of 1801 is the most interesting example. Here again, it is essentially the crank that is used as will be seen in the illustration of his engine given in Fig. 3. The following is an extract from a contemporary description:—

"The piston acts upon the circumference of the pulley *c*, by means of a chain, which is stretched over the pulley by a counter-weight. A crank on the axis of the pulley acts upon the lever *f*, by the connecting-rod *e*. At a point

nearer the fulcrum another rod *i*, connects the lever to a shorter crank *h*, upon the axis of the flywheel *g*. Suppose, in the first place, that the semi-circumference of the pulley is just equal to the travel of the piston, it is clear that while the piston moves between the top and bottom of the cylinder, by the alternate action of the steam and the counter-weight, the pulley *c* and its crank will be performing a semi-revolution on the same side of the centre, alternately upward and downward. And it is easy to see that while the crank *h* is likewise moved through a half revolution, on the ascending side, for example, it will be carried forward by the flywheel, and will perform its descending course on the other side. Thus, while a reciprocating rotary motion is communicated to the crank upon the axis of the pulley *c*, the flywheel shaft obtains a continuous rotary motion."

*Note.*—In Fig. 1, it would appear from the description that motion is imparted to the paddle-wheel in the reverse direction to that which would be convenient, and in Fig. 3, it would appear to be necessary for the link rods *i* and *e* to be pinned to the main lever. The descriptions and diagrams are, however, reproduced as accurately as possible from the original and the writer felt it to be undesirable that he should add any embellishments of his own.

(To be continued)

## A Simple Dial Indicator

(Continued from page 446)

A far simpler idea, in my opinion, would be to make the basic gauge first and then, in circumstances where greater accuracy is needed, to fit to the bottom of the case the small bracket and lever shown in Fig. 3, the measurements being made by point "P," the lever being twice as long one end as the other and, therefore, making each thou. equal to half a thou. The bracket holding the extra lever can be fitted to the back of the case, pinned into place and secured with two screws so that it can be removed. The pins will locate it when replaced; in its place can be fitted a longer bracket with a longer arm if needed for inside measurements. The screws and pins can also be used for holding it to a base for use as a comparator, and they can be screwed right through the case into the backplate so that the brackets become an integral part of the instrument.

For measuring such as bores of motor cylinders the device shown in Fig. 4 can be fitted to the pins and screws, and in this case it must be made very rigid as it has to be long enough to keep the gauge outside the bore for easy reading. In use the flat plate is pressed against the bore and the end of the adjustable rod, "R," presses against the opposite side and operates the gauge. Any degree of extra magnification can be had by suitable pivoting of the lever, and if rod, "R," is replaced by other lengths of rod, any bore can

be accommodated. Measuring wear of cylinder bores is referred to here, but for new bores the device could be set by a micrometer to the size needed and it would then indicate over or under this size.

No doubt, readers will think of other ways of adapting the instrument; likewise the provision of a movable dial, as in usual practice, is left to the reader. However, quite a lot of work can be done without it.

There is one point which deserves consideration. Even good quality fishing line is liable to suffer from damp, though no instrument should be kept in a place where it can become damp. In many cases it will not matter if the cord does absorb moisture to a small extent, since it will not affect the reading, and the zero can be reset by turning the dial. For those who need an instrument without this defect the cord can be replaced with a length of thin electrical resistance wire, generally ni-chrome, which is both very strong and not affected by rust. It is not so flexible as cord, but will grip very well if the drum is cut with a fine thread and the wire has six or more turns in the grooves of this thread; in this case the root diameter of the thread must be  $\frac{1}{16}$  in.; the overall diameter does not matter. A thread will suit for the fishing line as well, and will doubtless be easier to make than a small knurled spindle.

## Clubs

### Wicksteed Model Yacht and Power Boat Club

Members spent an interesting afternoon on Sunday, March 24th, when they visited Bedford to view the manufacture of a number of Marblehead yachts. The members were intrigued by the manner in which Mr. Latimer had built jigs and things so that these boats could be mass-produced. It was understood that these particular boats were likely to be sold for export; but should they come on the home market, model yachtsmen could be sure of obtaining a racing craft which would help to build up Model Yacht Clubs. Mr. Whitworth, the commodore, thanked Mr. Latimer for showing us round, and then invited all members to tea.

Hon. Secretary: J. G. SKRWS, 3, Lyveden Place, Kettering.

### The Society of Model and Experimental Engineers

The next meeting of the society will be held on Saturday, May 18th, when Mr. E. W. Brennan will give a talk on the building of his 3½-in. lathe. Arrangements have been made to have the lathe on show at the meeting, and members will have the opportunity of inspecting this, as well as taking part in the discussion. This meeting will be held at 39, Victoria Street, S.W.1.

Will all members and visitors please note that this and all Saturday meetings commence at 2.30 p.m., but for convenience of those who can arrive earlier, the Lecture Room is open from 2 p.m.?

Full particulars of the society may be obtained from the Secretary: J. J. PAGBY, 69, Chandos Avenue, Whetstone, N.20.

### A Club for Kettering

A movement is on foot for the establishment of a model engineering society for the busy town of Kettering. An inaugural meeting will be held on Wednesday, May 8th, at the Stamford Road School, at 7.30 p.m., when a cordial welcome awaits all enthusiasts in the district who can attend. Full information may be obtained from Mr. E. R. ADAMS, 18, Burns Road, Kettering, Northants.

### South London Model Engineering Society

The meeting for May 5th will be a talk on Boats, by Mr. N. W. Physick, A.I.E.E.; it will be held at King's College Sports Ground, Dog Kennel Hill, East Dulwich, at 11 a.m.

At the annual general meeting held on April 7th, the balance-sheet submitted by the treasurer showed the healthy state of the club's finances, while all officers of the society were asked to serve another year. The extensions to the club's track are now ready for service.

We shall be taking an active part in the forthcoming exhibition and track run of the Welling and District Model Engineering Society to be held early in May.

Full particulars of the society can be obtained on application from Hon. Secretary: W. R. COOK, 103, Engleheart Road, Catford, S.E.6.

### The Junior Institution of Engineers

Friday, May 3rd, at 6.30 p.m., at the Institution of Civil Engineers, Great George Street, Westminster, S.W.1. The third Stevens Memorial lecture entitled, "Processes of Destructive Hydrogenation," by R. H. Holroyd, B.Sc., Ph.D. The President, Sir George Paget Thomson, F.R.S., will preside. Admission will be by ticket, obtainable from the Secretary, The Junior Institution of Engineers (Incorporated), 39, Victoria Street, S.W.1.

Friday, May 10th, at 6.30 p.m., 39 Victoria Street, S.W.1. Discussion Groups.

Midland Section: Saturday, May 11th, at 4.30 p.m., Grand Hotel, Birmingham. Annual ladies' evening, tea and concert. Full particulars from Mr. A. J. WHEELER, Hon. Secretary, Midland Section, 6, Reeves Road, Birmingham 14.

Saturday, May 18th, at 1 for 1.30 p.m. Annual luncheon, to be held at the Connaught Rooms, Great Queen Street, Kingsway, W.C.1.

### Exeter and District Model Engineering Society

At 6.30 p.m., on Saturday, May 4th, at 49, Prospect Park, Exeter, Professor Newman will be speaking on "Electricity." Questions are invited.

On Saturday, June 1st, at 6.30 p.m., members are invited to look over the works of Industrial Motors Rewinding Co., of 31 and 32, Commercial Road, Exeter, by kind permission of their manager, Mr. S. Tombs.

Hon. Secretary: GEO. W. BELL, 44, Retreat Road, Topsham, Nr. Exeter, Devon.

### Tyneside Society of Model and Experimental Engineers

Future meetings will be held on Wednesday, May 8th, 7.30 p.m., at the Workshop, Manors Station. Feature programme by Railways Section; and on Saturday, May 25th, 2.45 p.m., at the Workshop. Lecture, "Design and Construction of Small Electric Motors," by F. L. Davies (member).

Hon. Secretary: S. G. JONES, 56, Moor Crescent, Gosforth.

### The York and District Society of Model and Experimental Engineers

The next meeting will be held at the Co-op. Hall, Railway Street, York, No. 11 room, Saturday, May 4th, 1946, 7 p.m. sharp.

Hon. Secretary: W. SHEARMAN, 28, Terry Street, York.

## NOTICES

The Editor invites correspondence and original contributions on all small power engineering and electrical subjects, which should be addressed to him at 23 Great Queen Street, London, W.C.2. Matter intended for publication should be clearly written, and should invariably bear the senders' name and address.

Readers desiring to see the Editor personally can only do so by making an appointment in advance.

All correspondence relating to sales of the paper and books to be addressed to THE SALES MANAGER, Percival Marshall and Co. Ltd., 23, Great Queen Street, London, W.C.2.

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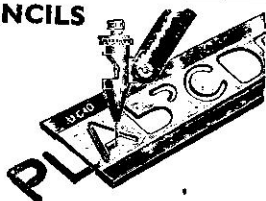
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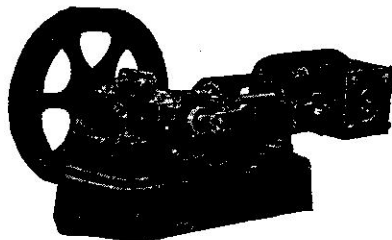
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Playwright

## PRIZES

**£100** For best idea    **£50** For Second    **£25** For Third

Not less than 9 consolation prizes of £10 each to be awarded at the discretion of the Directors

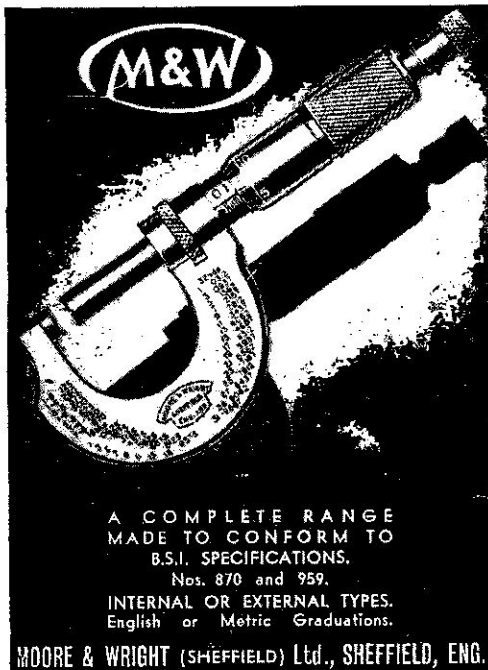
If Prize winners are not themselves Tobacconists their normal Supplier nominated by them, will receive: £20; £10 and £5 respectively.

## CONDITIONS OF ENTRY

1. There is no entrance fee.
2. The Competition is open to the Trade and Public alike including those serving in H.M. Forces.
3. There is no limit to the number of entries which each competitor may send in, provided each idea is submitted as a separate entry bearing in block letters the competitor's name and address, and the name and address of the competitor's tobacconist if competitor is not a member of the trade.
4. Entries may be sent in with or without a drawing or rough sketch, although such may be included if it is felt that it will assist in explaining the idea.
5. The decision of the Judges in respect of the 1st, 2nd and 3rd prizes, and of the Directors of Permalon, Ltd., in respect of consolation prizes, is final and legally binding.
6. The closing date for entries is Saturday, 15th June, 1946. All entries must be received not later than first post on that date, and should be addressed as follows:—  
**PERMALON Ltd., (Gomp.), Hills Place, Oxford Circus, London, W.1**  
*Proof of posting cannot be accepted as proof of delivery.*
7. All ideas submitted by entrants to whom prizes or consolation prizes are awarded shall become the sole property of Permalon Limited.
8. Such prizes or consolation prizes shall be full payment therefor. Entry for this competition implies an undertaking on the part of each successful entrant to assure and protect the idea at the expense and for the benefit of Permalon Limited.
9. Each idea submitted must be new and must not have been previously disclosed, published, offered or transferred.
10. Entries for this competition will not be accepted from employees of the PERMA Group of Companies.
11. The Judges and the Company cannot answer any correspondence relating to entries.
12. Prize Winners will be notified by post and their names published in the trade papers.

A more detailed leaflet is available on application to  
Permalon Ltd. at the address given above.

**PERMALON LIMITED**  
SPECIALISTS IN SMOKERS' REQUISITES



**A COMPLETE RANGE  
MADE TO CONFORM TO  
B.S.I. SPECIFICATIONS.**  
Nos. 870 and 959.  
**INTERNAL OR EXTERNAL TYPES.**  
English or Metric Graduations.

**MOORE & WRIGHT (SHEFFIELD) Ltd., SHEFFIELD, ENG.**

We send our best wishes to all our Model Making friends with the hope that our past good relations can now be resumed.

There are still supply difficulties, such as shortage of suitable labour, but we are doing our best to meet all demands.

## SURPLUS MACHINE TOOLS FOR DISPOSAL

**LATHES**—Crowthorne all-gear head, motorised, Gap-bed Lathe, £165. Ace 6-in. Tool-room Lathe, gap bed, chuck and steady, £295. Colchester "Master," gap-bed, S.C. Lathe, war finish, £285. Monarch 8-in. double-back-gear S.C. Lathe, Norton gearbox, £285. A.E.H. 4½-in. Precision Tool-room Lathe, 42-in. bed, £280. Lorch Precision Lathe, plain, £240. American Tool Works 6-in. S.C. Lathe, quick-change gearbox, £240. Southbend 4½-in. Precision Tool-room Lathe, motorised, £295. Southbend 4½-in. Precision Tool-room Lathe, quick-change gearbox, motorised, chucks, collets, £115. Britannia 6-in. Gap-bed Lathe, S.C., £235. Drummond 5-in. S.C. Lathe, motorised, 1½ h.p., motor, chuck, steady, £257. Atlas 5-in. motorised S.C. Lathe, on stand, £265. Sphere 5-in. S.C. Lathe, chucks and various equipment, bench Milling Machines, as new, each £245. Lang 10-in. Gap-bed Lathe, £240.

**CAPSTANS**—Ward 2A all-gear Capstan, 1½-in. capacity, ball chuck, s.p.d., £140. Wards Nos. 2 and 3 1½ in. and 1½ in. capacity, roller bearing heads, power feed to turret, complete with motor drive, each £285. Ward, Herbert, Barden & Oliver, Archdale, Warner & Swasey, 1 in. to 2 in., each £30.

**MILLING MACHINES**—Milwaukee all-gear single pulley drive, 48-in. table, £150. Pallas plain tool-room, 36-in. table, gearbox for feeds, £295. Becker 4B and 5B verticals, each £275. Weissner, Muller & Schuchhart light vertical Millers, each £235. Centac & Ajax, motorised, bench Milling Machines, as new, each £245.

**POWER SAWS**—Swiftcut, Speedax, Acme, Orien, and Manchester Rapidor, £10 to £62.

**GRINDERS**—Schutte Oilmatic, surface and tool and cutter grinder, motorised, £210. Brown & Sharpe No. 2 Surface Grinder, £100. Capco motorised, Surface Grinder, hand-operated, £87. Brown & Sharpe No. 1 Universal Cylindrical Grinder, 18 by 6 in., £125.

60 other machines. List free. Machines may be inspected any time, including week-ends.

**VICTA ENGINEERING COMPANY,  
MAIDENHEAD — BERKSHIRE**

\*PHONE 50.

## SANGAMO SYNCHRONOUS MOTORS

Self-starting, exceptionally good torque; rotor speed, 200 r.p.m., 200-250 V. a.c., 50 c. Consumption, 2½ watts. Size, 2½ in. x 2 in. Geared 1 rev. 60 min., can be reset to zero by friction drive from front or back. Shaft, ⅝ in. x 1/10 in., to run clockwise; ideal movements for making electric clocks, time switches, etc. Nickel-plated finish. Price 22/6 each. 12 to 1 Dial Trains to fit above spindle, per set 2/6.

## CHAMBERLAIN & HOOKHAM SYNCHRONOUS MOTORS

Enclosed type, self-starting, exceptionally good torque; rotor speed, 200 r.p.m., 200-250 V. a.c., 50 c. Consumption, 3 watts. Size, 2½ in. x 2 in. Geared 1 rev. 60 min., can be reset to zero by friction drive from front or back. Shaft, ⅝ in. x 1/10 in., to run clockwise; ideal movements for making electric clocks, time-switches, etc. Nickel-plated finish. Price 25/- each. 12 to 1 Dial Trains to fit above spindle, per set 2/6.

**15-AMP. MERCURY SWITCHES**, enclosed bakelite tubular cases, 2½ in. x ⅝ in., fitted swivel saddle, connector block, etc., 5/6 each.

**WIRE-WOUND NON-INDUCTIVE RESISTANCES**, 2 watt; ideal for meter shunts, resistance boxes, etc., 2½ per cent. accuracy, wound on bakelite bobbins, ⅝ in. x ⅝ in. One of each of the following ratings, 25, 50, 100, 200, 400, 600, 1,000 and 2,000 ohms, 5/6 per lot, postage paid; quantities available.

**ELECTRO MAGNETS**, 200-250 V. a.c., resistance 320 ohms, 1½ in. x 1½ in., 3/6 each.

**MOVING COIL HEADPHONES**, P.M., energised by Alni magnets, 45 ohms, ⅝ in. coil. Ideal for mikes, miniature loud-speakers, etc.; 1½ in. overall, in bakelite cases, with 3-in. front flange, 7/6 each.

**MOVING COIL MICROPHONES**, fitted as hand mic., with switch in handle, 45 ohms speech coil, 12/6 each.

**THROAT MICROPHONES**, fitted with elastic bands, 'phone plug, 15 ohms speech coils, etc., 7/6 each.

**RESPIRATOR CARBON MICROPHONES**, fitted 'phone plug, lead, etc., 5/6 each.

**CASH WITH ORDER. POST PAID ON ALL ABOVE GOODS. TO CALLERS ONLY.**—A comprehensive stock of scientific instruments, meters, gears, relays, etc.

**H. FRANKS, Scientific Stores,  
58, New Oxford Street, W.C.1.**

\*Phone: MUS. 9594.